Flexible Rail Milling Technology for Inner-City Areas

Inner-city local traffic requires a flexibly applicable maintenance solution for prolonging rail life.

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Reducing life cycle costs (LCC) of the track through prolonging rail life is an important topic for many owners of infrastructure. An optimised rail processing strategy can make a significant contribution to reaching this goal. In inner-city local traffic a flexible solution for rail processing is needed because of the external conditions. Especially for this scenario, Linsinger developed a flexible vehicle using Linsinger's tried and tested high performance milling technology to rebuild the initial state of the rail and therefore contribute decisively to prolonging rail life.

Challenges in Local Traffic

The inner-city local traffic tracks (trams, suburban railway and underground) struggle with growing demands due to tighter schedules, stronger vehicles and shorter time windows for maintenance because of extended operating times. The resulting burden leads to multiple damages, such as material deformation on profile- and microstructure level, signs of wear, waves or ridges (a combination of deformation and wear) as well as different damages that can be summarised as roll contact fatigues (RCF). RCF damages, such as head checks (periodic rips on the gauge corner), spalling (outbreaks on the gauge corner, evoked by head check rips grown together), squats and squat type defects also called studs (v-shaped rips on the rail surface combined with contact arc widening and spherical growth of rips below the surface) are typical in local traffic [1-3]. Furthermore, noise pollution is another challenge in urban areas. Singular damages, such as wheel burns, rail joints and defective welding can become singular sources of noise, while the defects mentioned above, like waves and squats, can lead to wide noise pollution due to their frequent and extensive occurrence.

Fig. 1a: Circumference milling wheel for re-profiling the rails and completely remove damages

Flexible Milling Technology

Linsinger is working on stationary milling technology since the 1960s and introduced the first mobile rail milling machine in the middle of the 1990s. The basis of this high performance milling technology is the circumference milling. A milling wheel working in longitudinal direction of the rail is making it possible to rebuild the diagonal and longitudinal profile within small tolerance as well as eliminate all surface defects in one processing (figure 1a). As this is a rotational cutting process, only milling chips are created (no dust), which are stored temporarily in the machine's chip storage for later recycling. In the same stage the second step, acoustic adjustment of the surface with completely enclosed circumference grinding wheels, takes place (figure 1b). All by-products of the process are also stored on the machine and disposed according to the regulations at a later time. In this step, only a "polishing" of the surface that creates an optimised finish takes place. To ensure no scraps stay on the rail head, it is brushed in the last step of the process (figure 1c). Linsinger's high performance milling technology is ideal for all maintenance work, such as preventative, cyclic or correcting maintenance, due to flexible processing depths of 0, 1 mm to 5 mm on the driving surface and 0, 1 mm to 7 mm on the gauge corner. As the Linsinger milling technology creates a very refined surface (faultlessness, small diagonal profile tolerance of +/- 0, 2 mm, minimal longitudinal waves of +/- 0, 01 mm and surface roughness of Ra < 7 µm) it is perfect for a predictive maintenance, which is even more efficient in costs and tool life. Especially for local traffic in urban

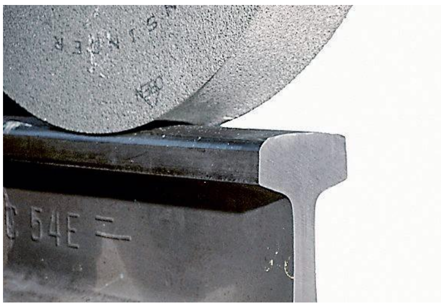

Fig. 1b: Circumference grinders for adjusting a noise optimised surface finish

Fig. 1c: Rotating wire brush for later cleaning of the rail surface

areas noise pollution plays an essential role. Thanks to the optimised, high-quality finish, a milled rail reduces noise more than conventional maintenance strategies (figure 2). Furthermore, the milling process itself produces less noise than traditional rail maintenance. Moreover, the rail surface is treated thermally careful. Material changes near the surface (white etching layers) are therefore completely avoided. This is important, as white etching layers on the tread can cause further damages like squats and squat type defects. The sensitive environment in cities requires minimised emission during processing. These requirements are met by the spark- and dust – free milling technology of Linsinger mills (innovative vacuuming solutions collect 99, 7 % of all emissions of the process). All common vignol- and groove rail types and rail grades can be processed problem-free according to the current norm (EN 13674, EN 14811). Linsinger is also working on future rail processing technologies (e.g. baintic rails). Especially for the requirements of inner-city areas, a flexible vehicle was developed: the Rail-Road-Truck SF02W-FS (figure 3). The drive between locations can be done on the road with a maximum speed of 80 km/h. Upon arriving at the destination, the vehicle can be put on the track (and put off the track) on a standard crossing or any other easily accessible part of the rail. Of course the drive between destinations is also possible in train mode with up to 45 km/h. The milling truck is equipped with one milling and on grinding unit per rail and can remove up to 1 mm of material in one overrun. On the gauge corner, a removal of up to 5 mm of material is possible, depending on the condition of the rails. As all Linsinger milling machines this machine type can also be used for processing

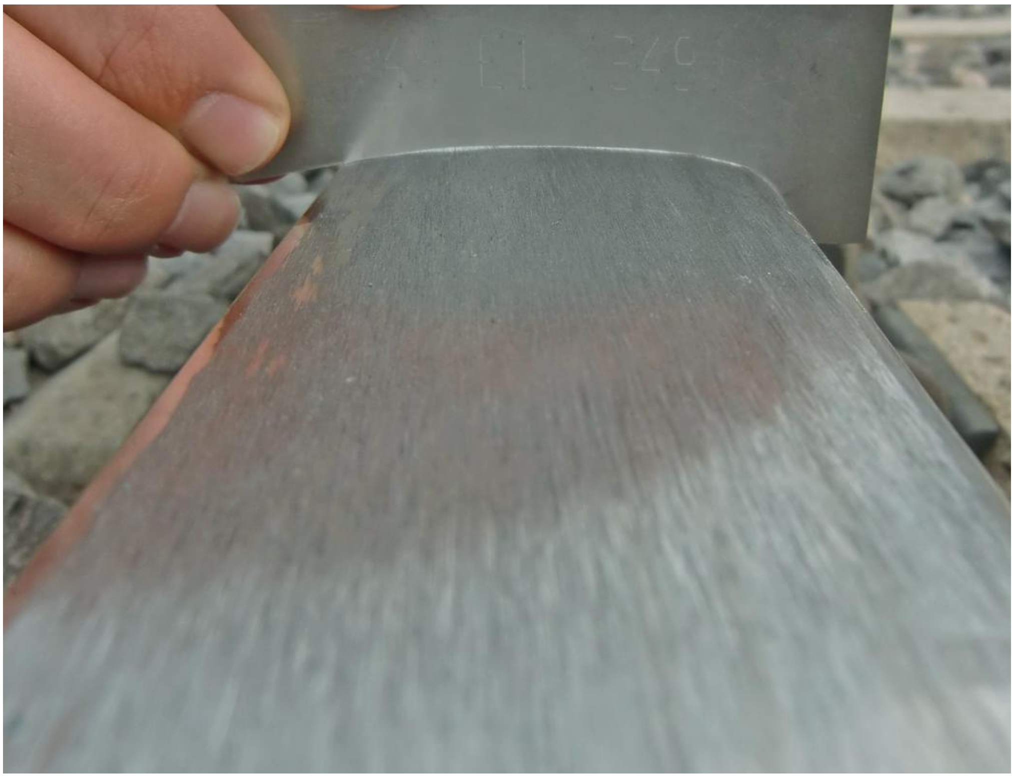

Fig. 2: Rail surface with a perfect surface finish processed with Linsinger high performance milling technology

Fig. 3: Rail-Road-Truck SF02W-FS (operated by Linmag Australia Pty. Ltd) with included workshop and spare parts container

Fig. 4: Squat type defects in multiple occurrences on the railway

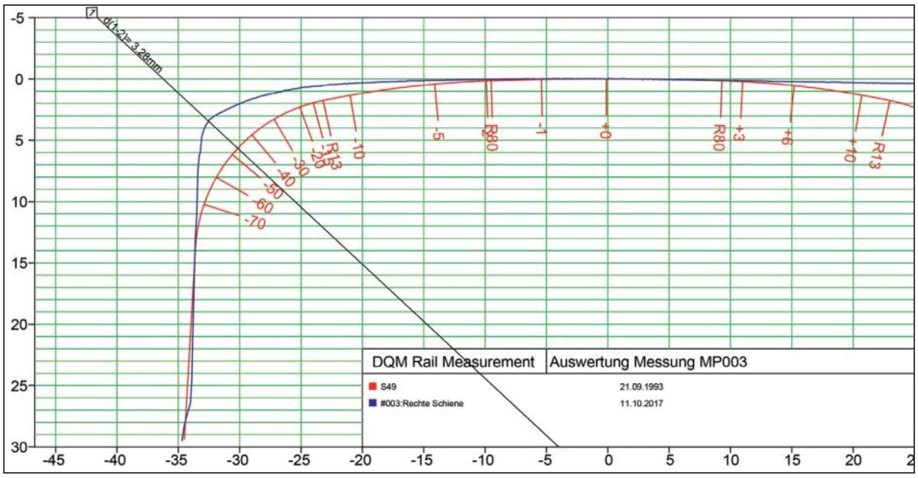

Fig. 5a: Measurement before milling, wear of the rails in comparison to the reference profile is clearly recognisable.

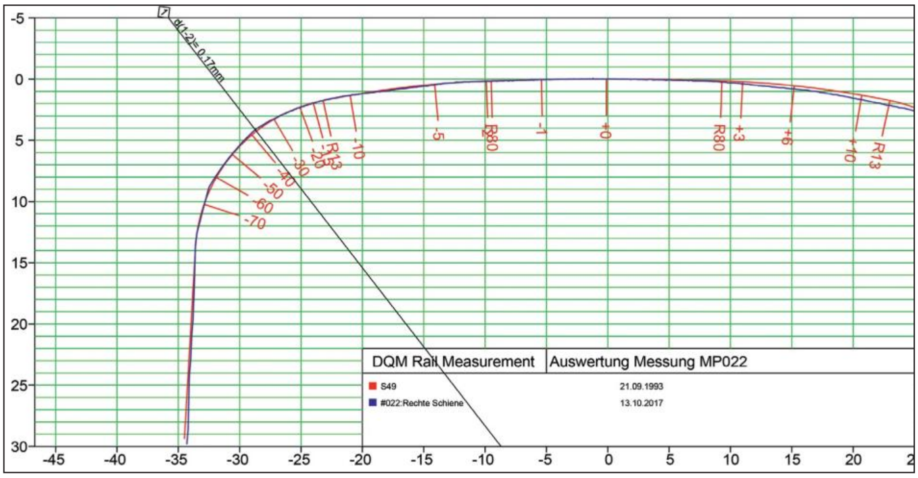

Fig. 5b: reference profile and real profile match perfectly after just one milling overrun.

normal rails, crossings and switches. Switches can be processed in one continuous overrun per rail (main rail, branch rail) without having to remove electrical track equipment or other components. Depending on requirements, the truck can also be equipped with eddy current measurement technology, in order to document diagonal and longitudinal profile as well as crack freeness. The truck is delivered with a mobile maintenance plant and spare parts container which makes it an autonomous unit independent from the circumstances at the customers locality.

Milling Technology in Inner-City Use

The flexible milling truck has been used for removing rail damages in Bonn for some years now. The focus is on removing those damages, but also on rebuilding the original state of the rails. Squat type defects (later on shortened to squats, figure 4) appeared multiple times in different parts of the rails in Bonn. Under the typical dents and broadened runway, cracks spread in the direction of the gauge corner. Consequential, material ruptures ("squat-lid" breaks off) occurred on the tread. Apart from reduced driving comfort for passengers, wheels and rails experienced extreme wear and squats spread further. A detailed analysis of the affected parts showed that the squat chains occurred especially in straight parts that showed less signs of wear. Literature suggests multiple factors that lead to such developments and it is difficult to identify the local factors in hindsight [4 and 5]. Because of the deepness and frequency of damages it was decided to remove the problems with Linsinger's Rail-Road-Truck SF02W-FS in order to avoid a premature renovation of the rails. Depending on the deepness of damages, a minimal removal depth of 1 mm was required, as a natural "driving away" of the damages was not to be expected due to wear-resistant contact. In one or in some places three overruns, the profile was restored precisely (figures 5a and b) and all squat type defects as

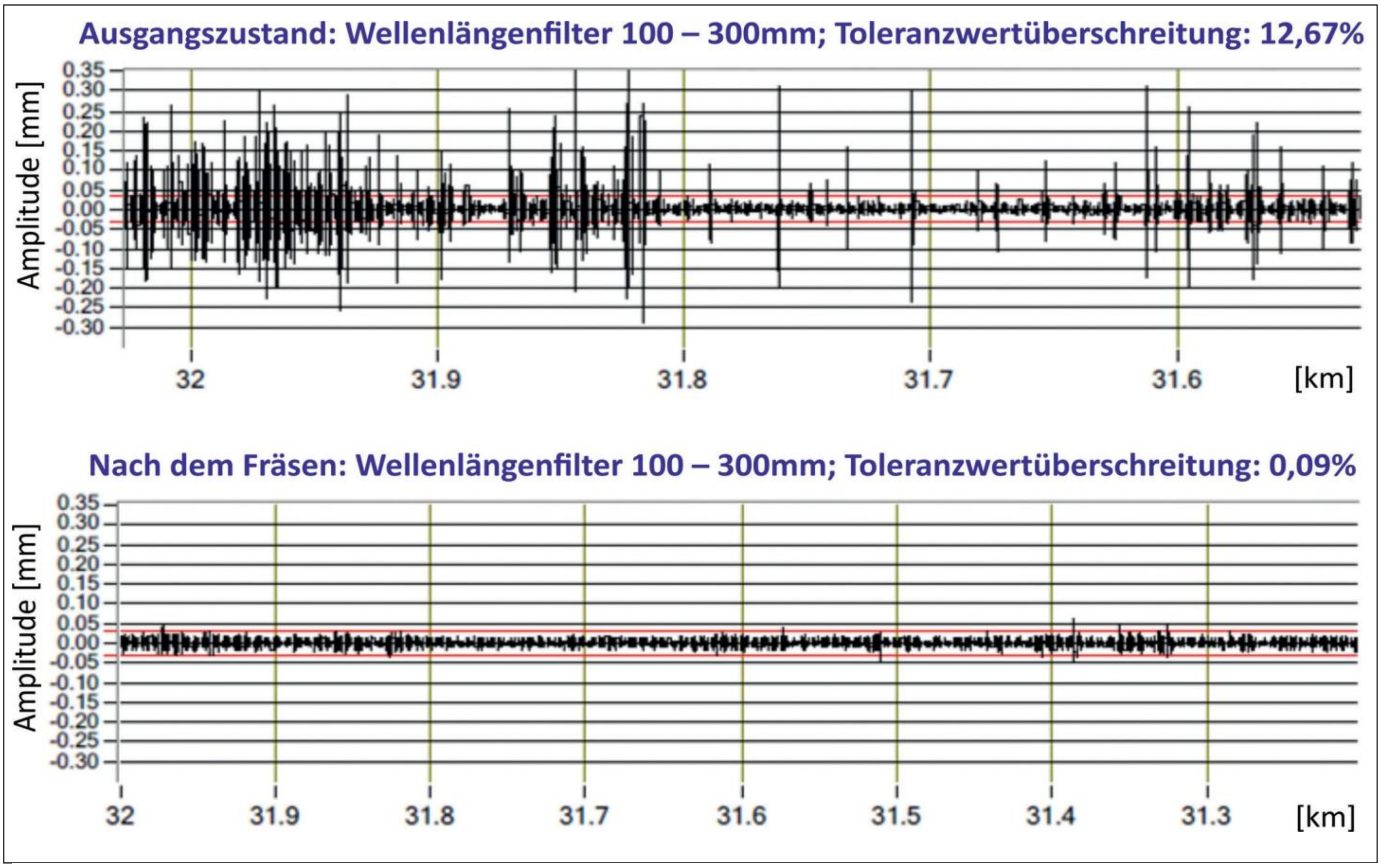

Fig. 6: Comparison of the longitudinal profile before and after milling. Initial state: waves with an amplitude of up to 0, 35 mm and 12, 67 % of the measured values outside of the tolerance of +/- 0, 03 mm. After milling: only 0, 09 % of the measured values are slightly outside of the tolerance.

well as other RCF-damages such as Head Checks or waves were removed. Material removal depth was chosen to be deeper in order to be sure that all damaged microstructure under the rips/ damages was removed which contributed to squat prevention. Thanks to Linsinger's high performance milling technology the driving comfort of customers was significantly improved, which was noticeable and appreciated in the feedback of customers. Figure 6 shows the measurement of the longitudinal profile before and after milling. Before milling, severe waves are detected, while afterwards all waves have been removed and only 0, 09 % of all measurements are outside of the range of tolerance. Usually, specifications allow for up to 5 % of the measured value to be outside of the range of tolerance. In the context of this campaign the flexibility of the truck was fully used, as depending on circumstance both the street and rails were used to drive to the site of operation and therefore the processing stops were used efficiently.

Restoring the Original Condition of Rails

To achieve a lasting improvement of the situation, it is of utmost importance to completely remove all of the damaged material including damaged/ deformed microstructures and simultaneously to not inflict any new damages and potential starting points for new damages. Only a completely faultless rail surface with a precise profile makes maximal rail life possible. Linsinger high performance milling technology makes a "reset" of the condition of rails in an effective way possible and therefore avoids the need for premature renovation. With this, Linsinger's innovative technology is contributing essentially to reducing railway life cycle costs by optimising rail life.

SOURCES

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