Innovative maintenance strategies and technologies for tunnels

Increasing demand for urban mobility require effective maintenance technologies for heavily used railway infrastructure.

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Radio news about daily traffic jams, extended commuting times to work, increasing parking fees and climate change: these are only a few arguments to switch to public transport in urban areas. Furthermore, free WLAN, air-conditioned vehicles and improved time tables provide additional comfort and motivation to choose rail transportation over individual car traffic. Public transport is nowadays a "must have" for any bigger city (not only from the environmental point of view). However, this requires innovative maintenance strategies to keep the railway track in a safe and operational condition that can handle this increased demand.

Urban Mobility

Subway systems represents the transportation back-bone of every bigger city. A huge number of passengers can be transported efficiently on a daily level by such as system. This is typically complemented by user friendly networks, a sufficiently high station density and sophisticated connections to other modes of public transportations like busses, tramways (light rail systems), intercity trains and even ferry connections. In addition, a subway does not consume any surface space in densely populated cities with very scarce real estate space.

Unknown to most of the passengers, a subway requires special maintenance attention in order to keep it operational. Customers focus on requirements like short train interval and possibly 24/ train operations. However, these customer requirements drive degradation of the railway infrastructure. Dense train intervals increase the daily traffic loads and at the same time maintenance windows are drastically reduced or simply do not exist anymore.

Urban rail maintenance

With the application of rail maintenance, it possible to keep passenger safety at a high level while at the same time significantly reducing the lifecycle costs of a rail network. Rail milling provides a significant contribution to achieve these two goals. This well proven process can remove all rail defects while at the same time creating a precise rail profile. This does not only positively affect rail life but also impacts vehicle wheel life. A well optimized rail-wheel contact can consequently impact both partners – rail as well as wheel – by reducing wear and damage development.

Gentle treatment

Rail milling is a gentle cutting process that efficiently removes material from the rail surface. The contact time between the cutting tools (cutting inserts) and the rail surface is limited to a few microseconds, therefore the process heat flows into the milling tool and milling chips. As a result, milling chips exhibit a characteristic bluing effect. The temperature of the rail stays in a low region during the whole cutting process. Simulations models and tests [1] determined that the rail surface temperature will raise slightly above 300°C during the milling process. This very low temperature does not cause any unwanted material transformations. It is possible to touch the rail directly behind the milling machine as the rail surface remains only at hand-warm temperature at this stage. In the case of conventional rail grinding rotating grinding stones are pressed with high pressure against the rail surface to create sufficient metal removal. This abrasive process creates rail surface temperature well beyond 700°C which can result in unwanted material transformation of the rail surface. These material transformations manifest in bluing of the rail surface or formation of so-called white etching layers (WEL). The name WEL is derived from optical microscopy. These layers are not etched by the typical etching agent (Nital) and do thereby appear white in a light microscope. These hard and brittle layers (compared to the base material) typically have a martensitic microstructure and can act as initiation points for micro cracks. Consequently, WELs can negatively impact rail life.

Clean and sustainable process

Rail milling is a virtually dust and spark free process. Linsinger as the inventor of mobile rail milling (located in Steyrermuehl/Austria) has perfected this process. A polishing unit is included in the milling machine (right after the milling tools) to create a noise optimized surface finish. Therefore, a circumferential grinding wheel with a small offset angle is used to eliminate the typical milling structure. As the contact pressure is very low, no material removal is taking place during the polishing process

resulting in minimum surface roughness levels (Fig. 1). The milling chips and the polishing dust are collected separately onboard the machine through an integrated suction system (efficiency > 99.5%). Consequently, tunnels stay clean

of harmful dust, that does not only impact human health but can also damage the tunnel infrastructure. This dust together with humidity can form an aggressive and corrosive mixture that can damage axle counter, switching machines and similar track hardware. Consequently, it is not necessary to do any cleaning of tunnels and stations after rail milling as it would be the case for traditional rail grinding.

The collection of the process by-product, the milling chips, can be directly translated into an environmental added value. Milling chips represent very clean steel material that can be 100% recycled as part of the steel production process. In clear contrast, conventional rail grinding simply distributes the mixture of steel dust and abrasive particles in the vicinity of the track resulting in environmental contamination instead of recycling valuable raw materials.

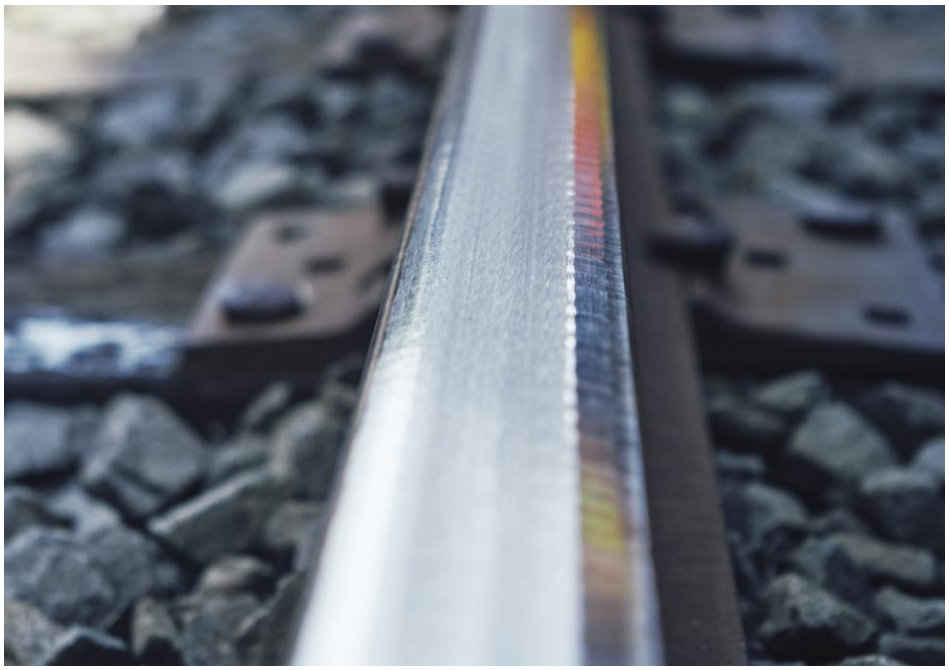

Fig. 1: The rail surface shows less rough after processing with Linsinger rail milling technology.

Efficient fire prevention

Prevention of fires in tunnels is a major concern for infrastructure owners. Rail milling is a virtually spark free process that minimizes the fire danger significantly. But also elevated track structures are prone to fire danger. Flying sparks caused by conventional rail grinding machines can damage parked cars or other nearby infrastructure. In May 2015 such grinding sparks ignited a bird's nest on an elevated structure of Vancouver Skytrain. This relatively small fire damage important cable lines resulting in a 13 hour long total shutdown of the system during the Friday morning rush hour. This highlights the significance of a functional and effective urban rail system for a vibrant metropolis like Vancouver. In addition, milling machines are equipped with an integrated fire detection and extinguisher system that can efficiently prevent on-board fires.

Application example at two cities

Linsinger milling technology is nowadays successfully applied on four different continents with a strong focus on regenerative/corrective maintenance strategies. Nevertheless, it is also used for cyclic preventive approaches and initial maintenance of new rails because of the above-mentioned advantages. This will be discussed in detail in the follow two application examples.

Initial Milling in Amsterdam

Prior to opening the new subway line M52 in Amsterdam (GVB), it was necessary to perform initial rail maintenance. On the one hand it was required to remove damage from rail installation (scratches, grooves, marks). On the other hand, empty trains were already running on the tracks on regular schedules (test subway operation) that resulted in minor rolling contact fatigue (RCF) and wear effects on the rail surface. Due to the restricted construction schedule (to meet the desired official opening date) it was necessary to concentrate all maintenance activities to a short time window of approximately 96 hours. After doing extended testing, GVB decided to use a LINSINGER MG11 milling machine for this challenging task (Fig. 2). This rail-bound machine was specifically developed to work in restricted clearance profiles of tunnels and in short (up to 2h) maintenance windows. Special procedures had to be applied to overcome the specific logistic challenges at GVB and to successfully master this 96h milling marathon. Initial maintenance with some additional spot corrections could be finished within the anticipated time frame due to the excellent collaboration between GVB and LINSINGER. It was possible to open the line in July 2018 offering the customers a safe and reliable subway experience [2].

Corrective rail treatment in Toronto

The Toronto subway (operated by TTC – Toronto Transit Commision) is the oldest subway network in Canada transporting more than 416 mio passengers each year. In the past, TTC used conventional rail grinding to control rail damage (RCF, corrugation) as well as profile degradation caused by wear with limited (or no) success. In addition, the high cleaning effort after grinding (dust) as well as morning shutdowns due to small paper fires (sparks) caused significant problems in the past. Therefore, TTC decided in August 2017 to publish the first dedicated milling tender ever in North America, which was won by the company Rhomberg Sersa North America Inc. The first milling shifts started in

Fig. 2: Usage of Linsinger rail milling machine MG11 at a station in Amsterdam. Dust free processing and without sparks in highest quality.

Fig. 3: Rail milling truck SF02W-FS (operated by Rhomberg Sersa Canada Ltd.) during rail processing at Torontos underground.

December 2018 by using a leased SF02W-FS milling truck (Fig. 3). This first work focused mainly on profile restoration of worn rails. However, milling did not only treat hotspots (as conventional grinding) in the TTC network but processed effectively whole track segments between stations. Due to the absence of dust and sparks, TTC was not required to implement any cleaning efforts for their stations and fire danger was successfully mitigated. In the coming years the whole network at TTC will be regenerated and treated with LINSINGER milling technology. Therefore, Rhomberg Sersa has purchased a SF02T-FS high performance transit milling machine that will be delivered by late 2020.

Rail milling for all system types

Despite focusing in this article on transit systems, rail milling can be applied to all railway environments – high speed lines, mixed traffic corridors, Intercity connections and heavy haul networks. All these systems do benefit from the advantages and capabilities of LINSINGER rail milling technology.

Urban rail transportation is one of the key elements to provide sustainable and environmentally friendly urban mobility. Rail mailing is providing an efficient maintenance technology resulting in high quality rail conditions. Therefore, customers can enjoy a safe, reliable and sustainable daily commute in cities all over the world.

References

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