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Permanent Way

Reduction of wear and noise by preventive and corrective grinding

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Prevention and correction of rail defects may be the most important topic for any public transportation system. Rail being an essential component to any railway, it is essential to preserve the rail and repair it with the right solutions, from damage caused by heavy rolling contact, dynamic load, and construction mistakes.

There is no doubt that rail with a high load under high speed, focused on a small contact zone, brings the highest stress on all superstructure components. So it is vital to keep the rail in good shape.

Defects of all sorts are often being seen such as shellings, squats, rail cracks, lipping, head checks and corrugation. The origin of these can be mostly found during production and installation of track as well as in wear appearances out of the daily rolling contact.

Depending on the vehicle concepts, wheel geometry and features like traction control, or mechanical actions such as heavy acceleration, braking systems and related forces initiated into the rail head, several wear consequences can grow with more or less intensity.

Rail grinding is recognised in Europe as the most efficient solution to preserve rails from premature replacement. Proper maintenance based on a periodic basis, enables good prevention of rail defects and avoids heavy wear of the rail head and gauge corner.

During the last decades, worldwide public transportation systems have focused on increasing quality and comfort for their passengers and minimising noise particularly in urban areas due to regulations.

Rail grinding is participating actively in those two areas. While rail grinding is mostly known for rail descaling on new rail and re-profiling worn head geometries, it is less recognised for its efficiency for noise reduction and improvement of longer lasting track.

However, there is no doubt a properly treated rail provides benefits for both smooth running and noise reduction as shown by many studies.

The benefits of grinding not only concern the rail directly, but also the superstructure and rolling stock so it is also an important source of cost saving.

Main Defects and Their Causes

Rail defects can be categorised into four main sub-categories: local defects, periodic defects, gauge failures and wear appearances.

Local defects could have different origins, even before the first train runs on the track. It can be rail handling mistakes during construction, or during loading the transport. In this case, main defects are pittings, local hits, bent rails, rail head damage when track is over ballasted and even rail cracks in serious cases. Other local damage may be caused by incorrect welding and heat treatment. Examples are superelevated

Example of shelling on the upper gauge corner.

joints or stress cracks. Last but not least, wheelburns may inflict serious damage to the rail head.

Periodic defects are caused by overloading, wear and incorrect wheel/rail geometry, high frictional forces or

Example of pitting

heavy breaking in certain areas. Main examples are lippings, short wave corrugation, head checks, or pittings.

Gauge failures are often caused by construction inaccuracy or broken during construction. Older cities' tramways with embedded track in Europe are facing this problem. It influences wheel/rail relation and ends up creating high wear and noise as a consequence.

Typical wear appearances are lippings on gauge corner and on outer rail head, as well as flat rail head and worn sectional head profile. In particular track sections with high frictional forces, such as narrow curves, turnouts and stations are sensitive to these.

Different vehicle concepts and rail wheel geometries that don¥t fit in combination with difficult track conditions, such as 25m radius, may accelerate rail and vehicle wear considerably and require regular maintenance in certain short cycles. But even the perfect network, new rail, new vehicle, straight track will not last very long in this condition without maintenance. It may sound unbelievable, but maintenance must start in the best case, even before the first train is rolling.

Preventive Grinding for Qualitative and Long Lasting Equipment

Considering damages on rail and rolling stock, it is important to prevent appearance of defects to avoid heavy repairs or rail replacement.

For new rails, these have to be treated within six months after installation to remove the rolled skin, and later on, only low material removal is necessary (0.01-0.05 mm) for preventive measures. Initial grinding removes the rolled skin and the area of increased hardness on the running surface, which may initiate later rail damage.

This layer may be 0.3mm thick. In Parallel, the removal of the high carbon rolled skin ensures better electrical contact and energetic efficiency, as most modern vehicles are driven electrically.

For optimal efficiency, grinding should be performed with either rotating or oscillated stones on a regular basis (annually or even bi-annually).

The intensity of grinding requires a clear concept. This means each network operator has to know his network and to recognise the sensitive track sections. For this matter, it is crucial to recognise the appearance of damage in the beginning state, where it is easy to remove them, so regular measurements are necessary.

In combination with the experience of maintenance staff, it must be the main goal to create a maintenance concept for the whole rail network, or section of responsibility.

These measures will tend to eliminate all small defects in the beginning, but also prevent rail from corrugation. This avoids heavy grinding or even milling, work that you will have to carry out when it is too late.

In these specific cases, the removal of 0.6 to 2mm is not an exception, compared with preventive grinding measures (0.05 to 0.1mm of removal). Heavy machining is very costly, especially if you take the reduction of rail material/ lifetime and track closing times into consideration. The conclusion is that prevention is the best option.

Additional costs for inspection, evaluation and supervision are far lower compared to the costs of removing serious corrugation or rail re-profiling. Furthermore knowing your network allows local treatment of weak points.

Corrective Grinding for Noise Reduction and Restoring the Rail Wheel Geometry

Corrective grinding is mostly applied when the sectional and longitudinal rail geometry needs to be re-profiled, but also to remove corrugation and head checks or simply cut off lippings, which mill away the rail wheel flanges of the vehicles rolling over it.

Corrugation is a main source for the increase in noise levels. For networks in urban areas with night operation, this may create trouble, not only for people living beside the track.

It is scientifically proven that corrugation height affects directly rail noise level.

Acoustically, the wave length range from 30mm-120mm is the most significant for noise increase. It can also increase the air borne noise level >10 dB, and in exception up to 20 dB.

In addition, vibrations caused by corrugation, might damage superstructure, wheelsets and bearings of rail vehicles. The life of corrugation may be compared to pot holes on the road. It appears in areas with high physical stress (braking zones for example), starts small and grows quickly.


Reprofiled rail with clear visible facets

Once you remove it, it will start to appear some time later. But it is also a fact that if you remove it early, it is much less work than making an "emergency repair".

The maintenance and supervision procedure explained above will demonstrate quickly that corrugation growth is very different and heavily depending on certain conditions.

European main lines are also facing head check problems these days. Once initiated, these small cracks can grow quickly at an angle of 45∞ into the rail head. In case they connect to a big check, massive pieces of the gauge corner can crack out and may even lead to rail cracks. Once recognised, quick action is required along with regular inspections.

Conclusion

Proper grinding is a good balance of machine, operators, measuring equipment and inspection staff experience, that decides where and how it makes sense to maintain the rail.

Once a maintenance concept exists, it is far easier to follow and to keep your network in good condition as well as the vehicles running over it.

Also, it will increase comfort for the end users.

Last but not least, grinding should be the most economical way to keep a network maintained in good condition, considering the impact a lack of maintenance may have on rail itself, superstructure and rolling stock .

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