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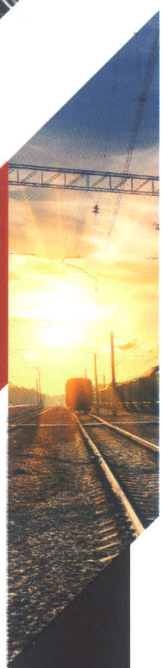

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Improved track superstructure due to Under-Sleeper Pads

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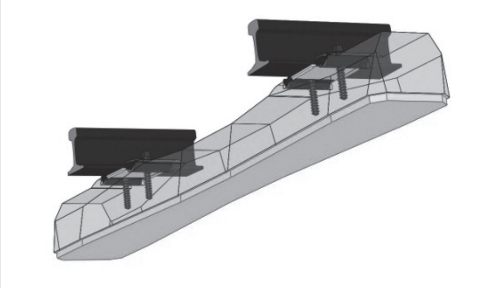
In the railway superstructure under-sleeper pads are primarily used for ballast protection and to improve the track quality. They increase the contact area between concrete sleepers and the top ballast layer, reduce the formation of hollowness beneath sleepers and lower superstructure settlements. Next to the standard track under-sleeper pads can also be used to smoothen the deflection of turnouts and increase the life cycle value of all track components.

I High-Quality Superstructure Systems based on Evenness and Resilience

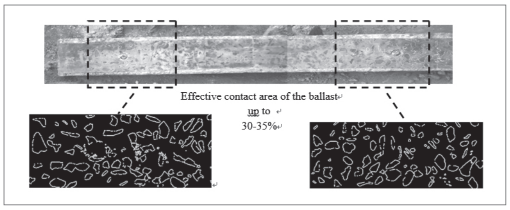
The more even the railway superstructure, the lower the force excitation when a train passes. The track panel itself is “floating” in the track superstructure. Repeated dynamic loads lead to changes in the track geometry over time, which leads to additional acceleration of the wheelsets. The forces generated alter the track bed quality. Hollow areas below the sleepers and signs of wear on the wheel and rail surface, both of which arise over time, increase these processes as well as being the result of them. The system vibrates more and more, thereby also increasing the emissions. By tamping and adjusting, the superstructure must be returned to its original position. The length of time this deterioration takes is largely dependent on the initial quality of the track superstructure[1]. The creation of the conditions necessary for a good, durable line that is as inherently stable as possible should therefore be the primary goal when installing new track. In this context, evenness and resilience are important starting points for a high-quality superstructure system. Through the defined arrangement of elastic elements, such as under-sleeper pads, the railway track edges nearer to achieving this goal.



[Figure 1] Under-sleeper pad beneath a concrete sleeper

II Improved Contact Area Using Under-Sleeper Pads

Arranging the under-sleeper pads under the concrete sleepers prevents a hard impression directly on the ballast. The upper-most layer of ballast can bed into the padding material, increasing the contact area (from 2-8% without padding, to 30-35% with padding) and thereby also avoiding excessive contact pressures. The larger ballast contact area and more even bedding lead to increased stability of the ballast bed, less track settlement and reduced wear to significant track components.

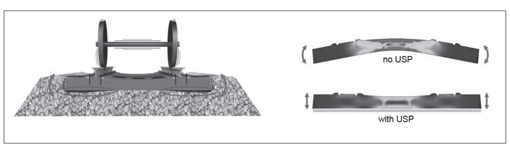


[Figure 2] Digital contact area analysis on a concrete sleeper with PU under-sleeper pad removed from a track in service (pore scan method)

As laboratory tests and track measurements show, the lateral resistance of padded sleepers is consistently higher than that of conventional concrete sleepers. With under-sleeper pads, which permit comparably deeper bedding-in of the ballast stones due to their specific material properties, resulting in a larger area of contact ratio, a further increase in lateral track resistance was measured[2]. In a padded line with ballast, the formation of voids is almost entirely avoided. This fact in particular shows that the padded concrete sleepers have a significantly better position behaviour. For example, while fairly strongly pronounced voids arose over time between the undersides of the sleepers and the ballast bed in 7 out of 10 unpadded concrete sleepers in the Austrian Federal Railways'

1. Veit, P.; Marschnig, S.: Towards a more sustainable track. Railway Gazette International, January 2011, p. 42-44
2. Iliev, D.: Versuche mit elastisch besohlten Schwellen – Elastizität, Kontaktspannungen, Querverschiebewiderstand [Trials using elastically padded sleepers – elasticity, contact stress, lateral resistance]. Getzner Bahnfachtagung Schwarzenberg / Vorarlberg, October 2011

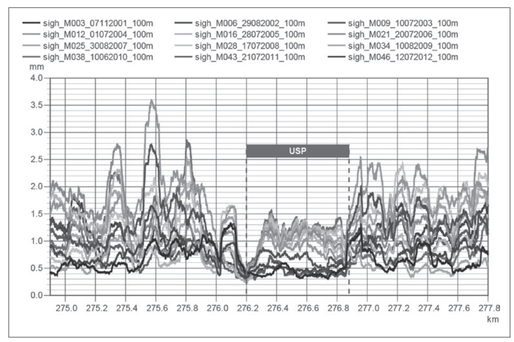
network, no void formation could be detected in the measured sections with padding[3]. Deviation in the track quality is significantly lower in padded sections than in unpadded sections. These properties have led to the under-sleeper pads bringing about a significant improvement in the traditional ballasted track. Not least because of this, padded sleepers have become established as the standard form of construction in the Austrian Federal Railways' network. In the mainline network today, concrete sleepers with under-sleeper pads are used as standard in new track and turnout installations.



[Figure 3] Void formation only under unpadded concrete sleepers. Such voids are avoided by using under-sleeper pads, which makes load transfer more even

III Increased tamping cycles and improved life cycle costs

With the above described increased contact area of the sleeper the load deflection is higher and all track components as well as the ballast are less used. The Austrian Federal Railway had a high number of test sites before changing their standard track into track with under-sleeper pads. In these test sites an enlargement of the tamping cycle by factor 2.7 and a long lasting good quality of the track could be proved. Figure 4 shows the standard deviation of a track within an improved track area. With this improved track bed less maintenance and therefore less track blocking times will be needed and the life cycle costs of the track will be enhanced.



[Figure 4] Track quality measurements show the benefits of the use of Under-Sleeper Pad (USP) track

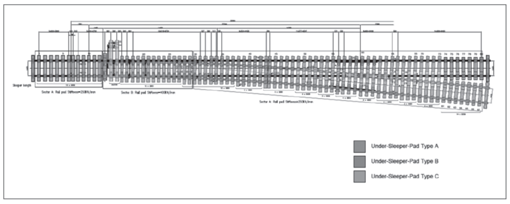
IV Under-Sleeper Pads in Turnouts

Due to their complex geometries, the expense and costs of track maintenance are significantly higher for turnouts than for straight tracks. Specifically, the stiffness differences of the track bedding in the direction of travel, which are structurally determined by the design of the turnouts, lead to different rail deflections. This results in additional stresses on the superstructure caused by crossing trains. With the use of elastic

3. Auer, F.: Einfluss von elastischen Komponenten auf das Gleisverhalten [The influence of elastic components on the track behaviour]. ÖVG Tagung Salzburg, Volume 104, 2011, p. 53–55

under-sleeper pads it is possible to achieve significant improvements in terms of track stability and vibration protection. The ballast is less stressed and the tamping intervals thereby increased. The life cycle costs (LCC) of a switch can be significantly reduced.

In order to be able to deliberately introduce the system of elastically mounted turnouts in the ballast track, the demands on the elasticity and the behavior during a train crossing must be understood. Due to this requirement, Getzner Werkstoffe has developed a non-linear calculation model based on the Finite Element Method (FEM). This FEM model offers the possibility of placing the Sylomer® or Sylodyn® elastic under-sleeper pads in the various areas within a turnout so that stiffness jumps can be graded in a sliding manner and thus significantly reduced.



[Figure 5] Optimized turnout with different under-sleeper pads

V Summary and Conclusion

With the introduction of under-sleeper pads into the track superstructure an improved track bed can be established. Next to the benefits with enlarged contact are and therefore less hollow sleepers, breaking rail clips or white spots within the track bed, the under-sleeper pad is enlarging the load distribution onto a higher number of sleepers. With this the tamping cycles can be reduced up to a factor of 2.7 and with this the life cycle value of the track enlarged. These advantages can also be used in turnouts with fast changing sleeper geometries and deflections. With a special allocation of different under-sleeper pad types the rail deflection of passing trains can be balanced.