Volume 7, Issue 32 – January 2016

ISSN No. 0976-254X

www.railbizindia.com

Rail Business

[FOCUS-INDIA]

PACING PROGRESS

RENEWED VIGOUR IN RAIL SECTOR

₹ 100

Optimization at track transition zones by specially engineered PU pads

'A chain is only as strong as its weakest link' applies equally to a railway network, as the time at which track maintenance has to be carried out is determined by its most sensitive section, usually a transition zone. These are found in areas where the continuous support provided to the superstructure and bedding is interrupted and the stiffness of the track substructure alters, like at interfaces between slab and ballasted track, open track traversing a bridge, tunnel or culvert.

Discontinuities may also occur in systems of the same type. Due to the varying degrees of stiffness and the associated deflection differences, any abrupt change in track parameters from one type of superstructure to another result in increased dynamic stress. A rail vehicle has to cross a step, which can lead to sudden increases in the wheel/rail forces. These impacts significantly accelerate the wear of the superstructure and lead to ballast settlement and damage to individual components.

Across the transition zone from ballasted track to slab track, settlement of the ballast as a result of its movement and wear is unavoidable. It is therefore necessary to tamp the track at regular intervals to prevent voids and hollow areas underneath the sleepers.

The slab track, because of its solid design, exhibits less or even no settlement, resulting in the running surface of the ballasted track becoming lower than that of the slab track. When combined with a local change in stiffness, the resulting height difference places a significantly increased dynamic stress on the super structure that can generate excessive loads around the rail seats.

With time the frequently occurring wear indications intensify the problem like white spots due to excessive ballast abrasion, settlement caused by high specific loads and short pitch corrugation on the rail surface. Hollowness and voids underneath the sleepers can result in overloading, the breaking of rail clips, bolts and sleepers, or even fracturing of respective components. Any short pitch corrugation in the transition zone can be seen as a phenomenon arising from the widely differing natural frequencies of the different superstructures.

Increased maintenance

Such damage scenarios lead to increased maintenance of transition zones and higher costs. Data from the Netherlands show that transition zones require between two and four times as much maintenance as normal stretches of track.

The proportion of transition zones is vanishingly small, implying that the somewhat higher investment costs, because of using the best possible elastic superstructure components and a technically optimized solution, are recovered very quickly.

Transition zones with varying track stiffness need extra maintenance and absorb disproportionate maintenance effort.

The main criteria that need to be satisfied are:

- Reducing dynamic effects at local changes in track stiffness.
- Adjustment of existing track stiffness differences.
- Lowering settlement especially in the transition zone to fixed constraint points.
- Optimal length of the transition zone with respect to costs and benefits.

The classical ballasted track is usually too stiff and has to be joined to softer zones, e.g. a slab track with highly elastic rail seats.

For optimal results, it can be recommended that the stiffness change is such that the computed deflection difference between the individual sections is no more than 0.2 to 0.5 mm.

For the transition length, an engineering rule of thumb is to make the transition as long as necessary (benefit) while keeping it as short as possible (cost). Depending on the source, the 0.5 sec, 0.7 sec or 1 sec rule is frequently used i.e. the length is determined by the time it takes to cross it, without it being shorter than the absolute minimum length of the distance between the bogies.

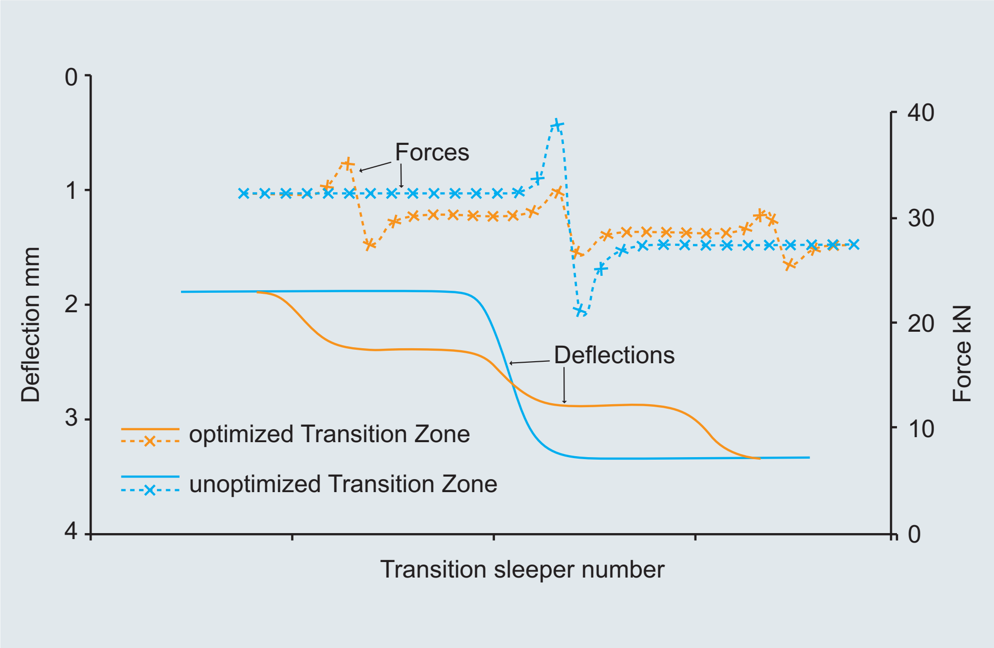
Common approaches

Normally, the aim is to distribute the local discontinuity in the track parameters across a wider area. The change in stiffness should be carried out continuously, or in small steps, in order to minimise the dynamic stress on the superstructure, leading to splitting the transition into individual sections.

getzner engineering a quiet future

Martin Quirchmair
System Development
Getzner Werkstoffe

Harald Loy
Head of System Development



On high-speed lines, transition zones can extend over six or more sections. The typical constituent parts of these solutions usually comprise guardrails, ballast bonding, or transition slabs. These solutions satisfy the demands very well, but are expensive and, from a commercial perspective, cannot be used along standard tracks. Simpler, lower cost solutions are used in many applications.

Elastic superstructure components based on PU (Polyurethane) offer one alternative or addition to these partial solutions. The special properties of this material allow the stiffness of the superstructure to be defined very precisely (elastic properties), while its complementary relationship with the ballast provides protection in the long term (plastic properties).

Optimization with elasticity

The use of high-quality elastomers enables undefined levels of stiffness to be replaced by defined ones. Depending on the superstructure, adaptation of the stiffness can be performed using rail pads, baseplate pads, under-sleeper pads, sub ballast mats, mass-spring systems or elastic insert pads for sleeper boots.

This is where the strengths of high-quality PU products, such as Getzner's Sylomer® and Sylodyn®, come to the fore. In contrast to rubber-based materials, no softeners are used that might diffuse out during the lifetime of the material and stiffness remains unchanging and defined for its entire service life. The properties of PU materials exhibit a high degree of variability. Sylomer® and Sylodyn® materials can be tailored to the product and supplied with outstanding dynamic properties or, if desired, with a high plastic character.

The interlocking of ballast stones with the pad reduces settlement and leads to less ballast movement, improving the stability of the overall railway superstructure.

The adaptability offered by PU enables a broad range of products with finely graded degrees of stiffness and material properties, in turn allowing the varying track parameters across the individual sections of the transition zone to be perfectly matched. In addition, the top ballast layer is stabilised by becoming embedded in the pad. There is less vibration, reducing the ballast movement. The critical frequency range within which the ballast stones in the ballast bed wear more quickly begins at an excitation of about 30 Hz.

Proven in the field

On standard tracks, various track types are often connected directly without intervening sections. The problems arising can be significantly alleviated, even retrospectively, by dividing the transition into a number of sections. The fitting of additional elastic elements can be achieved without rebuilding the entire superstructure, as in the case of construction of a bridge in Mexico.

Here, a stretch of ballasted track had been connected to a slab track in the classical way. As no particular attention had been paid to this critical transition zone, characteristic white spots associated with ballast abrasion became apparent very quickly. Further, the effect of high dynamic forces had loosened the fastening bolts and the slab track surface was damaged.

To compensate for the unevenness of the damaged slab track, adjusting plates from Sylomer® were fitted between the rail seat and the concrete. Soft, elastic Sylodyn® rail pads placed directly under the rail foot ensured excellent load distribution and good dynamic properties. In the transition zone, 25 sleepers were padded with elastoplastic Sylomer®, which markedly reduced settlement and provided a smooth transition with considerably less wear.

Modern simulation methods help engineers develop an all-embracing design that takes account of the differing elastic layers. A transition zone that has been optimized in terms of stiffness and settlement helps sustain track quality for longer and increases the availability of the network. Laboratory experiments and in-situ measurements round off the theoretical studies. This facilitates the targeted use of rail pads, baseplate pads or under-sleeper pads. Existing conflict points can even be retrospectively neutralised without having to rebuild the entire superstructure.

The amount of knowledge and experience gathered internationally in recent years will enable to help network operators quickly and effectively whenever individual transition zone problems occur. RB