

Advanced Rail Fastenings in India



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By F.A. Wingler, February 2021

PREFACE:

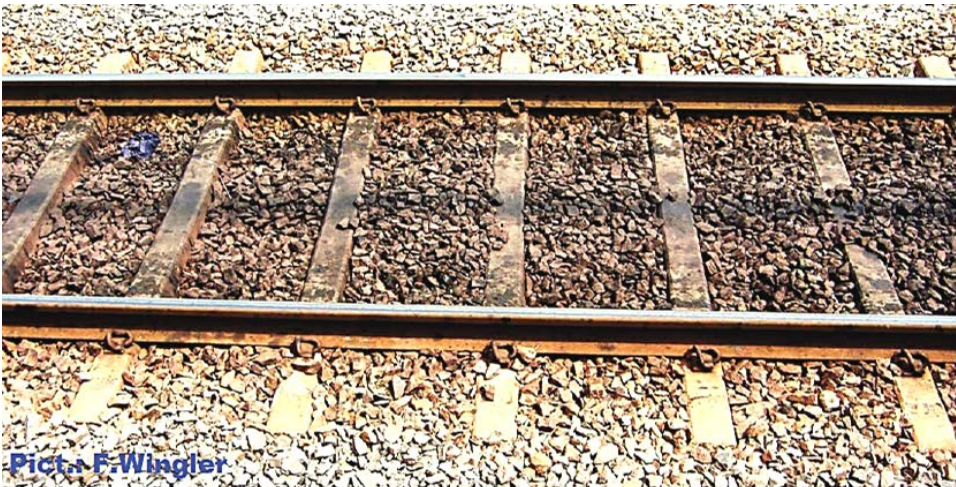
With advanced Turnouts, Metro Rail, Ballast-less Rail Tracks, Regional Rapid Transits and High-Speed Line new impetus has been given to the Indian rail fastening market and applications. The spectrum of advanced rail fastening assemblies has become wider.

The promotion of indigenous manufacture of advanced rail fastening components under **"Make in India"** will give an impetus to the Aatmanirbhar Bharat Initiative under the self reliant Indian campaign making better use of the domestic economy and industries.



RDSO designed elastic Rail Clip, ERC, MARK III the Standard of INR:

The RDSO designed anti-clock-wise bended self-tensioning Elastic Rail Clips, ERCs, evolved from Pandrol ERCs, are in India the standard rail fastening for concrete sleeper rail tracks:



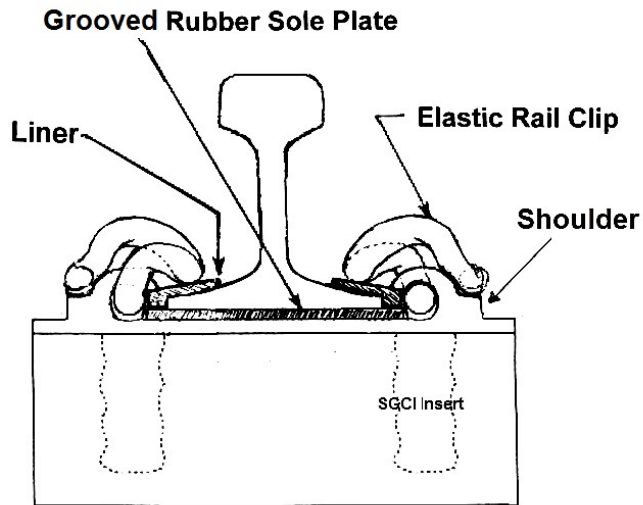
INR Ballasted Concrete Sleeper Rail Track with ERC Fastening

The standard fastening consists of only few parts; an SGCI insert with a tunnel/housing and a shoulder anchored in the concrete sleeper, an insulating glass filled nylon composite GFN liner, a 6 mm thick grooved rubber rail-pad and a self-tensioning ERC. The concrete sleeper comes with the insert already casted in.

Those Pandrol type ERCs develop the clamping force to hold the rail foot by deflection when the centre leg is pushed into the housing/tunnel of the SGCI insert with its shoulder. There is NO LOAD, developing a clamping force. The clamping force develops with the deflection of the spring steel rod. The missing elasticity of concrete sleepers gets compensated with elastic rubber pads made out of natural rubber, ethylene-vinylacetate-copolymer (EVA) or ethylene-propylene-dien-ter-polymer micro foam (microcellular EPDM). Between heel of the clip and rail-foot there is a liner made out of enforced polyamide/nylon. There is no screw or bolt to adjust the clamping force measured with the unit [kN]:



Assembling of Indian RDSO designed MARK III ERC on Concrete Sleeper by pushing the Centre-Leg into the Housing/Tunnel; Pict. by F.A. Wingler



Elastic Fastening with self-tensioning RDSO MARK III ERC on Concrete Sleeper; Graph modified by F.A. Wingler

The rail fastenings with MARK III ERC on INR concrete sleeper tracks need frequent attendance. By vibration and corrosion the clip can get loose. A patrolling key man is in intervals needed to push manually with a special hammer loose ERCs back into the housing:



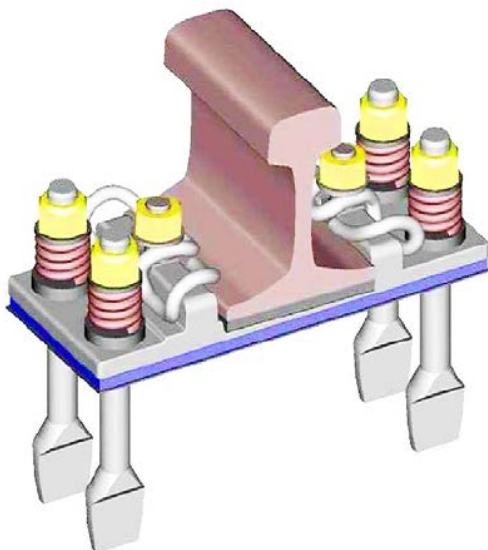
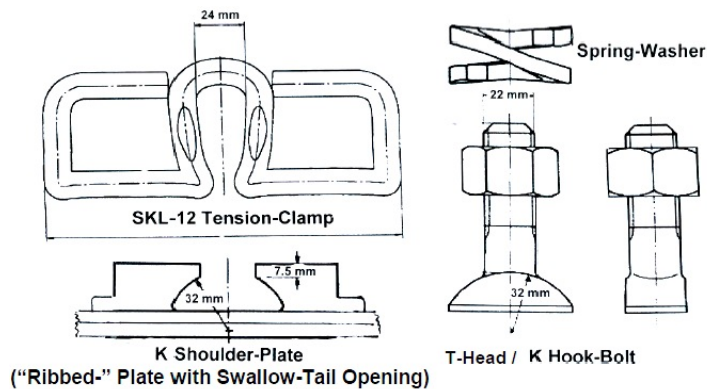
Attending loose MARK III ERC by patrolling Key Man

On Metro Rail, Semi-High Speed and High-Speed tracks, because of safety reasons a so-called ***"fit-and-forget"*** attendance free fastening system is needed. Metro Rail, Semi-High Speed and High-Speed Rail need more reliable fastenings and components.

Indirect Base-Plate Fastenings for Metro Rail:

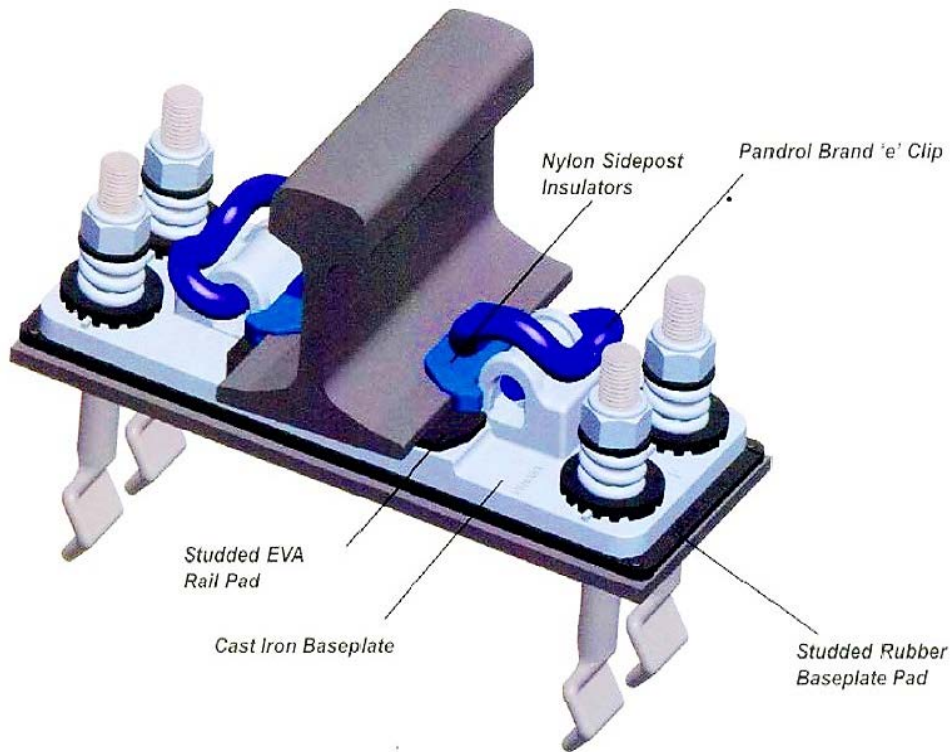
With the upcoming Metro Rail in India, alternative ***"fit-and-forget"*** **indirect** fastening assemblies have arrived making use of **Base-Plates** with either

1. the **Vossloh K-Plate** (***"Rippen-Platte/Ribbed-Plate"***) with the T-Head/Hook-Bolt and the SKI 12 Tension Clamp (***"Spann-Klemme"***) for indirect fastening:



Vossloh 336 4 Holes Ribbed Base-Plate Fastening with Anchor Studs, K-Head Bolt and SKI 12 Tension Clamp

2. or with shoulder Base Plates with tunnels/housings for **Pandrol** type ERCs for indirect fastenings. The Pandrol resilient base plates of this **indirect** fastening are fixed to the sleeper or plinth by cast-in anchor studs:



Pandrol resilient Base-Plate for "e" Brand Pandrol ERCs

On the old Kolkata metro line one can find the self-tensioning Indian ERC clips with anti-clock-wise bends.

The **Vossloh** type 336 ribbed base-plate **indirect** fastening with T-head/K-bolts and SKI 12 tension clamps are installed on following operational metro lines:

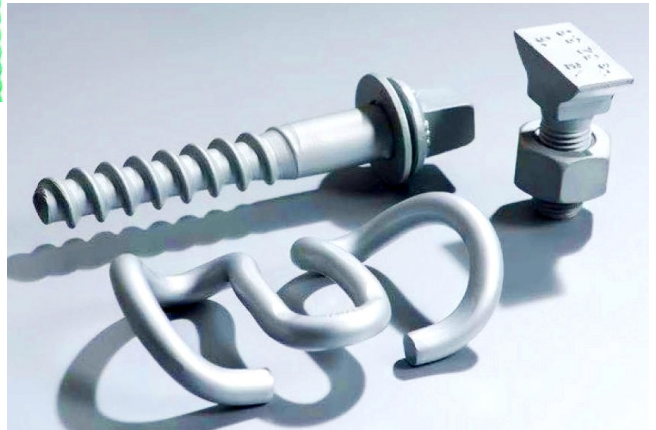
DELHI (BG and SG), JAIPUR, NOOIDA, GURGAON, KOCHI, KOLKATA (new), BANGALORE, LUCKNOW, HYDERABAD and AHMEDABAD:



Bangalore Metro Rail Fastening with 4 Holes Ribbed Base-Plate, K-Bolt and SKI 12 Tension Clamp

The Vossloh, Germany, supplied **indirect** fastening system-336 with SKI-12 tension clamp and Cellentic intermediate plate is installed on the Bangalore Metro. The base plate system uses an M 27 x 285 mm cast-in anchor stud assembly. Two bolts are used on curves leaner than 700 m radius, 4 bolts on curves tighter than 400 m and 3 bolts for curves < 700 m and ≥ 400 m. The fastening system is capable of lateral adjustment of ± 4 mm using eccentric insulating bushes, and of vertical adjustment of $+ 20$ mm using a combination of height adjustment plates beneath the base plate.

The fasteners are spaced at 700 mm on tangent track and on curves of radius 400 m and leaner. The spacing is reduced to 650 mm on curves tighter than 400 m radius. This system has a proven record in Indian conditions of over 10 years on the Broad Gauge and Standard Gauge rail tracks of Delhi Metro Rail Corporation. Its performance in reach-1 of the Bangalore Metro for the last 14 months (2013) has been quite satisfactory; source: S. Parameshwara, Procedure of National Technical Seminar of IPWE, Jan. 11-12th, 2013, Chennai, Page 332.



Vossloh 336 2 Holes Ribbed Base-Plate Fastening with Screw-Bolt Dowel Combination, K-Head Bolt and SKI 12 Tension Clamp

The **indirect** Pandrol Resilient Base-Plate Assembly with Pandrol “e” Brand clock-wise bended ERC one can find on following Indian Metro Rail:

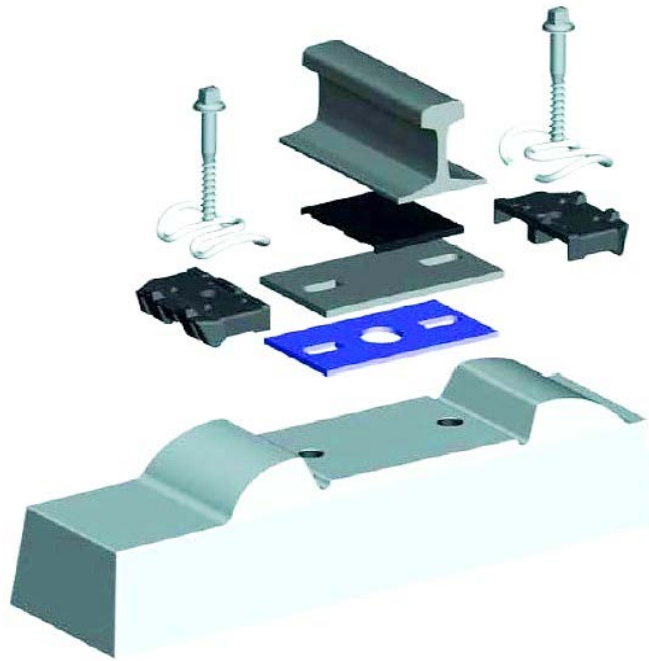
DELHI, CHENNAI, MUMBAI, KOLKATA new, NAGPUR and PUNE.

This installation is similar to the Pandrol installation of Dubai Metro Rail, where however only two anchor studs are used.

Direct Vossloh 300 Series SKI Tension Clamp Fastening:

For Ballast-less INR Tracks, BLT, in Tunnels the **direct** Vossloh 300-1 U fastening system with SKI tension clamps have also come to India. The assembly is hold by screw bolts with dowels in the concrete sleeper or concrete plinth. When fastening and tightening the nut or screw-bolt, the SKI clamp gets deflected and thus generated the clamping force.

The clamping force can be adjusted by the torque applied. The vertical height can be adjusted with intermediate plates/shims; the lateral adjustment can be performed with the angle-guide plates:



Assembly Scheme of Vossloh 300-1 U direct Fastening with SKI 15 Tension Clamp



Angle-Guide Plate of Vossloh 300-1 U Fastening

The Vossloh 300 direct screw-bolt fastening is a favorite assembly on Rheda 2000 ballast-less tracks, BLT, in India:



Preparing Rheda 2000 BLT Track in T 80 Tunnel (USBRL Project) with Vossloh 300-1-U direct Fastening with SKI 15 Tension Clamp



Bi-Block M-55 non-prestressed Concrete Sleeper for Rheda 2000 BLT with Dowel Holes for Vossloh 300-1 U direct Fastening for Tunnel T 80

The bi-block traverse, non-prestressed concrete sleepers together with rail fastenings and rails are adjusted in their position to precision on a monolithic concrete track-supporting layer (i.e., monolithic in that it is created in one concrete-casting process) and then the concrete poured between the sleepers:



Construction of Rheda 2000 HS BLT in Saudi Arabia, Jeddah to Medina

On the BLT of **Delhi Airport Express Metro Rail** we find the Vossloh 300-1 U **direct** fastening system with SKI 15 tension clamps, similar to the BLT fastenings of the Indian Railways, Northern Railway, Pir Panjal Tunnel T-80 and Tunnel T-25 of the USBRL, Kashmir link project:



Pict. by F. Wingle

Delhi Airport Express Metro Rail direct Vossloh 300 Fastening with SKI 15 Tension Clamp

Brief History of SKI Tension Clamps:

The SKI 12 had been introduced in 1988 in European Railways to replace the K-type clamps on indirect ribbed base-plate fastenings on wooden and concrete sleepers (introduced in Germany 1926) and is nowadays especially used on turnouts, also on INR. The SKI 14 had been introduced 1976 with the Hermann Maier, HM, direct fastening on concrete sleepers. In Austria, on Continuous Welded Tracks, CWT, with tight curvatures, a stronger SKI 28 with a higher clamping force of 14 kN is since 2001 in use:

Table: Clamping Force and Vibration Amplitude of SKI

Tension Clamp	Clamping Force	Vertical Vibration Amplitude
SKI 1	9 kN	1,2 mm
SKI 14	10 kN	1,8 mm
SKI 28	14 kN	3,0 mm



SKI 12 for indirect Fastening on Ribbed Bas-Plate on advanced INR Turnout, Bilaspur, India

SKI 28 on direct HM Fastening on ÖBB Track with tight Curvature, Austria; Pict. by Dr. Florian Auer, Austria



Self-tensioning Pandrol Fast Clips superseding the “e” Brand ERCs:

Worldwide the self-tensioning Pandrol-Brand Fast-Clips are increasingly superseding the self-tensioning Pandrol type ERCs. The Fast-Clip falls in the category of **indirect** fastenings. This Fast-Clip takes a trumped around the globe especially in England, Germany, France, Poland, Sweden, Estonia, Georgia, Lithuania, Russia, Serbia, Hungary, Corsica, Sri Lanka, Cambodia, Malaysia, Saudi Arabia, Australia, China and USA:



Pandrol/Rahee Fast Clip; Pict. by F.A. Wingler

In England, wherever new sleepers get installed, the rails will be fastened by Fast-Clips. Even in Germany, the motherland of direct Vossloh Screw/Tension-Clamp SKI Fastenings, the Fast-Clips are nowadays installed on tracks with tight curvatures, where in 4-5 years interval due to high wear the high outer curve-rails have to be re-railed by robotic heavy-duty on-track machinery (River Rhine Valley Lines):



Mechanized/robotic Track Sleeper Laying with pre-assembled Fast-Clips, Rail-Threading and Clip-Locking in China

The Fast-Clip sleepers are delivered on site with all components held captive, and the clips with the toe-insulator are at parked position. Once the sleepers are placed and the rail has been threaded, the Fast-Clip is simply pushed from the parked to the installed position. This can be done by mechanized/robotic procedures. The correct clamping force in the range up to 17 kN is achieved automatically when pushing the clip in parking position.

The Fast-Clip is virtually maintenance free and a true *"fit and forget"* rail-fastening. Even under harsh conditions the clip does not dislodge. No key-man is needed to push in regular intervals clips back, as it is needed for conventional parallel to the rail installed elastic rail clips, which can get loosened by rail-creep and vibration.

For the Mumbai-Ahmedabad High-Speed Line the Fast-Clip has been taken into consideration in combination with the Japanese Shinkansen ballast-less slab track. A demonstration track had been recently installed at Vadodara:



Demonstration of Ballast-less Slab Track at Vadodara for Indian High-Speed Project with Base-Plate Fast-Clip Fastening



Pandrol Vipa DFC indirect Base-Plate Fastening with Fast-Clip

The **Pandrol VIPA** DFC is a base-plate system with Fast-Clip, and it has been designed with pre-cast applications in mind. This has allowed the engineers to design the system economically using long-proven embedded cast shoulder technology to transfer the lateral loading into the pre-cast element. Applications are on light rail, metro, high-speed and other non-ballasted tracks.

The Pandrol VIPA range of products uses 2 layers of resilience pads to provide attenuation of vibrations, 1 layer of resilience pad under the base-plate and a second layer under the rail.

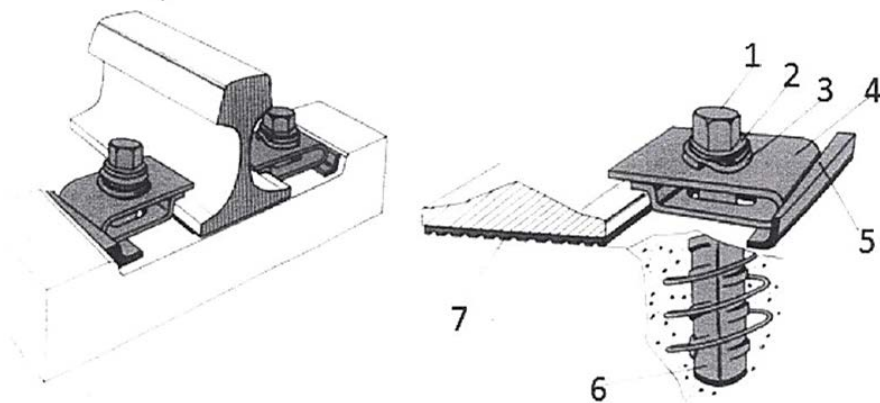
The system is an adjustable indirect base-plate type, ideally suited for installation on pre-cast blocks, sleepers or slabs, but can also be installed using the wet-pour top-down methods like Rheda 2000.

Direct Shinkansen Spring-Steel Leaf Fastening:

A feasible alternative for the Mumbai-Ahmedabad HS track is the Japanese spring-steel leaf fastening of the Shinkansen lines, a **direct** fastening assembly using dowels in the concrete support:



Spring-Steel Leaf Clip Fastening of Shinkansen HS, Japan



1: Hexagonal Bold; 2: Washer; 3: Coil Spring; 4: Spring-Clip; 5: Wedge;
6: Plastic Dowel; 7: Rail-Pad

Scheme of the Japanese Shinkansen Spring-Steel Leaf Fastening

This fastening allows lateral adjustments. The clamping force is achieved automatically once the screw-bolt is tightened to contact.

Direct Nabla Spring-Steel Blade Fastening:

A similar **direct** spring-steel leaf or blade fastening with screw bolts is the Nabla system with a roughly triangular shape of the clamping steel

blade. The term “Nabla” is derived from the triangular symbol resembling an inverted Greek delta used in mathematics:



Roughly Triangular Shape of the Nabla Clamping Spring-Steel Blade

The Nabla fastening is a safe and reliable railway fastening, which is most widely used in France. In general, Nabla fastening can be widely used in tram, light rail transits, metro, main line and high-speed tracks. The special shape of the Nabla blade generates a dynamically stable clamping force on the steel rails when the screw-bolt gets torqued.

The **direct** Nabla fastening is extensively used on concrete sleepers of ballasted French TGV high-speed lines:



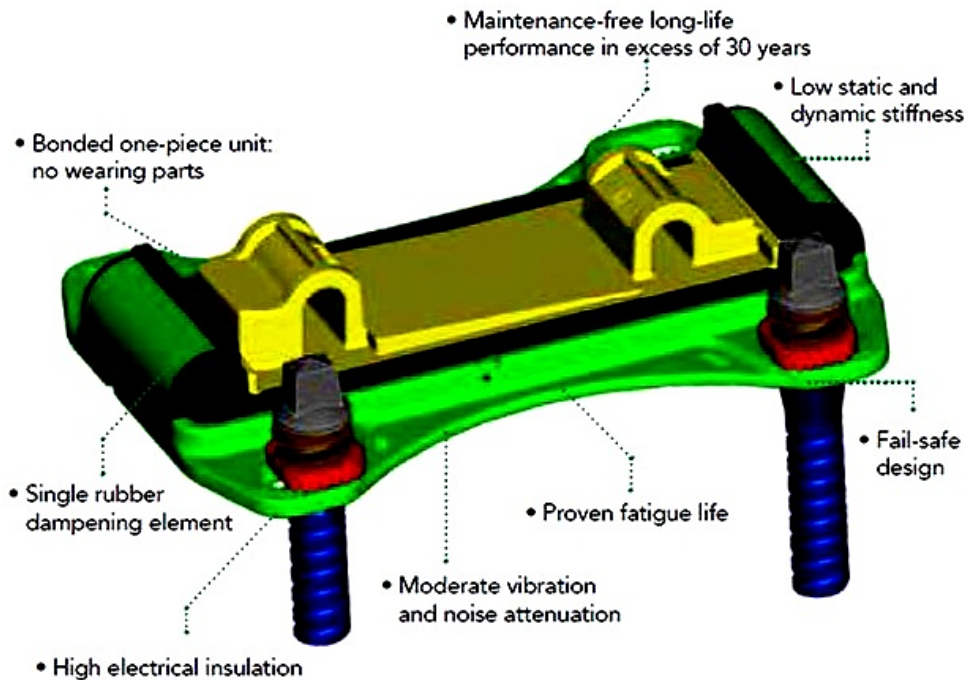
Nabla Spring-Steel Blade Assembly Scheme with Insulator

Besides the **indirect** Pandrol Fast Clip the **direct** Nabla assembly is also taken into consideration for the Mumbai-Ahmedabad HS BLT rail track.

Indirect Delkor Base-Plate Fastenings:

In his article on *Rail Link to Kashmir Valley* in the PWI Journal, London, UK, January 2021, p. 18, the renowned consultant Mr. J.S. Mundrey promotes for the envisaged ballast-less track, BLT, on the Kashmir rail-link between Katra and Banihal an indirect fastening with **Delkor** base-plates.

Delkor, Australia, has in its product portfolio a wide range of adjustable base-plates for ribbed plate K-bolt-SKI as well for Pandrol type ERCs clips:



Delkor Alt. 1 Bonded Base Plate; source DELKOR RAIL Product Information Sheet; modified by F.A. Wingler



Delkor Alt. 1 Base-Plate Range

Elastic Rail Pads and Intermediate Plates:

Elastic vibration energy absorbing and clamping rail pads and intermediate plates are essential components of advanced rail fastening systems. For details see: J.S. Mundrey, RAILWAY TRACK ENGINEERING, 5th Edition 2017, McGraw Hill Education (India) Private Limited, Chennai, Chapter 5, p.170 ff, ISBN (13)-978-93-5260-649-8 / ISBN (10): 93-5260-649-3:



Standard grooved Elastomer Rail Pad of INR manufactured by
Chandra Industrial Works, Kolkata

Rail pads and intermediate plates of advanced properties are made of vulcanized microcellular ethylene-propylene-diene-termonomer (EPDM) rubber, of different stiffness adjusted to the applications, under the trademark "**CELLENTIC**":



Vossloh *CELLENTIC* Rail Pad for 300 Series direct Fastening



Intermediate Plates for the Vossloh 300 Series direct Fastenings

Outlook:

The final words have not yet been spoken, which of the advanced indirect or direct rail fastening systems and components will become standard in India.

The national strategy should be to manufacture the advanced rail fastening components in India.

The promotion of indigenous manufacture of advanced rail fastening components under **"Make in India"** will give an impetus to the Aatmanirbhar Bharat initiative under the self reliant Indian campaign with the target to make better use of the domestic economy and industries.

Within the Aatmanirbhar Bharat Initiative, Pandrol Rahee Technologies Pvt. Ltd. have become an innovative supplier of advanced rail fastening components in India. They have taken SKI tension-clamps and Nabla fasteners in their product portfolio.

