Road embedded Rail Track for City Tram, Light Rail Transit and Metro-Lite

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Introduction

The origin for **LIGHT RAIL TRANSIT or "METRO-LITE"** is based on electric City Trams, that started worldwide at the end of the last but one century. **Light Rail Transit** is becoming a further mainstay for urban and suburban public transport in India under the term *"METRO-LITE"*. In India, we find a relic of the last century in Kolkata:

Iconic Kolkata City Tram reached the 21st Century

LIGHT RAIL TRANSITS, LRT, including City Trams, experience worldwide a renaissance. LRT is currently the fastest-growing passenger rail mode, employing a full range of technologies and operational practices. Around the globe, light rail systems, or LRT, have become increasingly popular in recent years due to their lower capital costs and increased reliability compared with heavy rail systems.

In Central European countries, LRT/city trams remained operating since hundred years uninterrupted as the backbone for urban, suburban interurban and regional public transport.

Be it the tram in the classical sense or the suburban and interurban railways, that combine features of underground railways and trams, the global future of urban transport is on the rail with Light Rail Transits. While the construction and running of underground or elevated systems incur huge costs, tram and light rail transit systems can be constructed and integrated into the city-scape at a comparatively lower cost.

Light Metro Rail (LMR) or Light Rail Transit (LRT) is now regarded as feasible for India under the name ***"Metro Lite"***. Delhi Metro Rail Corporation has already initiated India's first Metro Lite project for the corridor between Kirti Nagar-Bamnoli in Delhi:

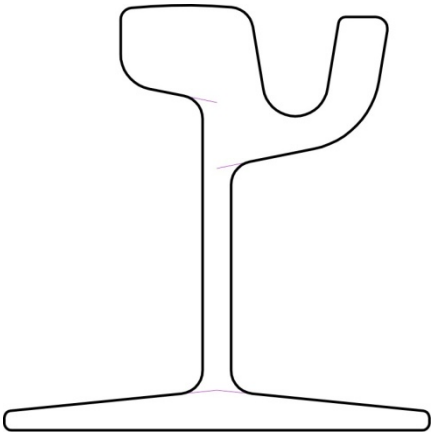
Representative Image for Delhi-Metro-Lite; Pict.: Canberra, Australia; Source: Metro Rail News

Metrolite is planned in India for cities with lower ridership projection and as a feeder system for existing metro systems. It will cater to lower passenger capacity at a reduced cost than a metro line. Further cities envisaged for Metro-Lite are Bangalore, Chennai, Dehradun, Gorakhpur, Jammu, Kochi, Allahabad, Raipur and Visakhapatnam.

The Light Rail Systems can share their ways with road traffic, blending in the surrounding road surface, and as well use their own dedicated tracks on reserved corridors.

I. Track Structure

In 1880 the steel German steel manufacturer Phönix AG, Ruhrort, rolled the first flat bottom grooved Vignole rails for the Plymouth tramway in England to be embedded in the road bed for a mixed traffic to flush with the road surface. The grooved tram rail combines in one piece a running rail with a check rail. In Kolkata one can still detect instead of the one component grooved rail the two component combination of running and check rail.



Cross Section of grooved Vignole Rail for City Tramways

Plymouth Tramway in the 1880-ties

II. Ballast-less embedded Tramway Track Assembly without Cross Ties / Sleepers

The width of a tramway grooved rail foots are in the range of 150 to 180 mm providing a large support area. The conventional way of track laying had been to lay the rail grids with gauge distance bars bolted to the web without support of cross-ties (sleepers) direct on a aligned and resilient planum, consisting of compacted gravel, metal, bitumen, asphalt, cement, mortar or concrete, or nowadays on elastic noise and vibration attenuation mats. Normally, height adjustment of such tracks takes place by insertion of wedges, and by pouring compounds under the track panel.

Tramway Track Laying in Germany in the early 1990-ties

Track Structure of Kolkata Tram at Tollyganj Tram Depot; Pict. by Ashis Mitra

The rail-web chambers are flanged with stones, bricks, mortar or bitumen, and the aligned track levelled up to integrate with the road surface with paver blocks, cobble stones, asphalt-mixtures or concrete. This ***"sleeper-less"*** methodology is even nowadays in use:

Laying of Tramway Rail Track on levelled Concrete Planum / Formation

Laying of Sleeper-less Tramway Track on a Concrete Slab

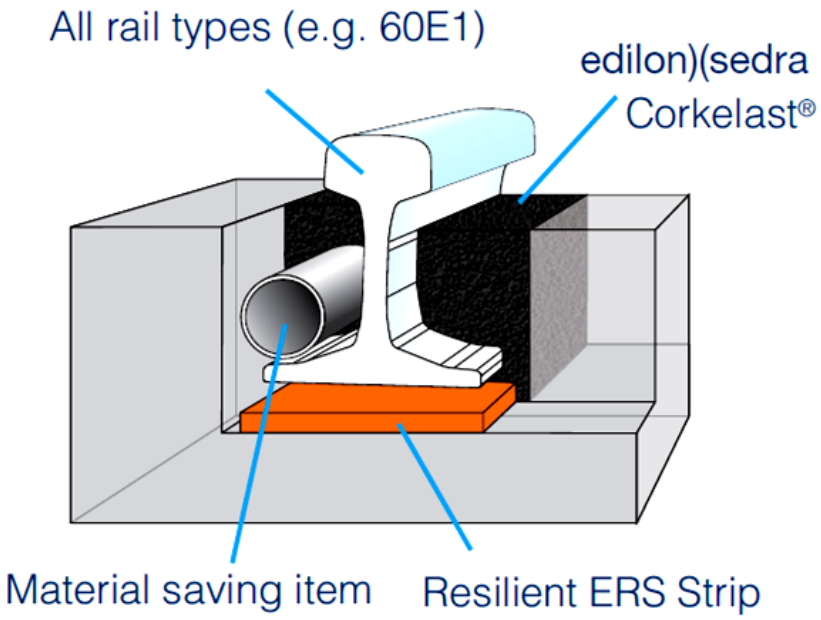
Tramway Track covered with Paving Blocks / Cobble Stones

Tramway Track blended to Road Surface with Concrete Cover Plates

Advanced systems bring the sleeper-less rail grids on support points and level/align the rails with screw-spindles before casting cement or mortar between the rails up to the road level. The rail-web chambers between rail food and rail head get filled with vibration and noise attenuation materials to isolate the rail from the soil mitigating ground borne noise and vibration penetration in the surrounding area:

Assembling of modern Tramway Track on Support-Points; Freiburg, Germany

To meet the demands of stakeholders of reducing ground borne vibration and sound, the **EDILON SEDRA Embedded Rail System (ERS)** keeps rails in position with a cork filled elastomeric polyurethane composition poured around the rail in a structural groove without the use of conventional rail fastenings and cross-ties/sleepers. The ERS rail fastening system is characterized by continuous support of the rails, as well as by the elimination of any and all forms of small hardware components. This also means avoidance of the support-point frequencies of traditional, discrete rail fastening systems, and it enables transfer of live traffic loads more uniformly and with reduced load peaks into the supporting track substructure:



Edilon embedded Rail

The main product in the ERS rail fastening system results from enclosing and bonding the rails with the 2 component ***"edilon)(sedra Corkelast®"*** embedding compound in a concrete or steel channel. This unique, long-life material ensures that the rails have homogeneous support throughout, with specifically determined elasticity, in accordance with specified conditions. ***"edilon)(sedra Corkelast®"*** is a polymer embedding compound with hardness and quantities of filling material (e.g. cork), that depend on the product type. Resilient ERS Strips controls the rail deflection under the prevailing loads. Such strip mats are available with various thickness and hardness characteristics, according to requirements for system stiffness. The filling material used here primarily serves to reduce the use of embedding compound. Empty tubes employed for the same purpose can also be used to enclose cables for signals and other functions.

Edilon embedded Grooved Rail for Noise and Vibration reducing Tramway Track blending in the surrounding Road Surface

Preparing in Situ the Grooved Concrete Support for Edilon Tramway Track at Athens, Greece

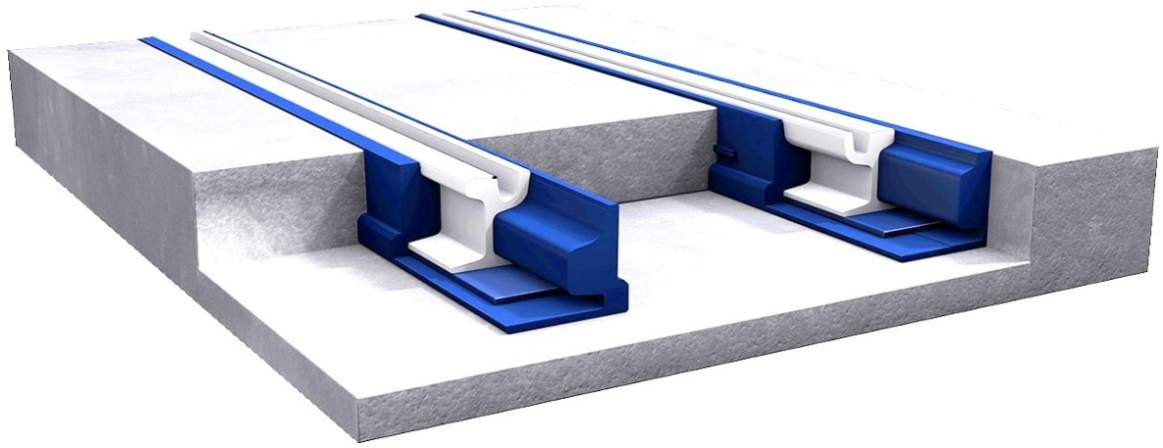
The grooved track-support can be a prefabricated cast concrete slab. The varieties of covering of the track with asphalt, grass, paving stones/blocks, concrete and concrete with impressed pattern give planners the possibility to embed the tracks into the scene:

Prefabricated grooved Concrete Slab covered with Grass at Chemnitz, Germany

Tramway rails are subjected to heavy wear, especially in tight curvatures and tight turnout/crossings. The embedding Edilon system allows easy rail replacements/renewals.

Another system, which isolates the rails from the surrounding material for sound and vibration attenuation is the **Ballast-less and Sleeper-less embedded PANDROL QTRACK®.** It is a continuously supported and fastened assembly, where the rail is completely encapsulated by elastic prefabricated resin bonded rubber profiles with a unique shape and adapted stiffness characteristics. The system, when installed in concrete gutters, provides support to all sides of the rail and allows stringent vertical and lateral support and at the same time offers vibratory and electrical decoupling and stray current insulation from its surroundings. Worldwide 600 km QTrack had been laid. Amongst in other cities, it had been successfully been installed in Firenze, Italy, for the Tram-lines 2 and 3 running through the sensitive historical area and in Sydney, Australia for the catenary free 2 km section from Town Hall to the northern terminus at Circular Quay,

which is equipped with Alstom's APS ground-level power supply to allow the catenary-free operation. APS uses an embedded third rail to supply power to trams, with the conductive segments live only while a tram is passing over them. The Pandrol QTrack® provides the needed electric insulation:

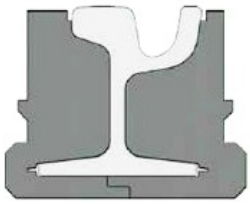


Polymer encapsulated Noise and Vibration reduced grooved Tram Rails in Pandrol QTrack®

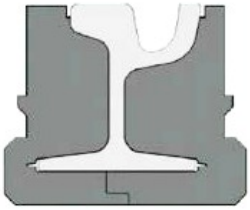
Lowering of encapsulated Vignola Rails in prefabricated Concrete Gutters with adjustable QT JIGs before Adjusting and Fixing with a Filler Material

Cross Section of ready Pandrol QTrack Assembly

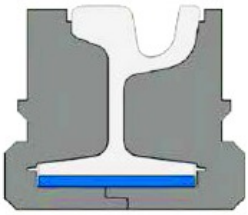
The Pandrol QTrack system has varying stiffness in the bottom strips, which can provide up to 12 dBv sound mitigation. Bottom strips as shown below can be chosen based on the noise and vibration mitigation required:



The Pandrol QTrack® - SP variation for LRT:
1-2 dBv mitigation



The Pandrol QTrack® – HP variation for LRT:
3-5 dBv mitigation



The Pandrol QTrack® - XP variation for LRT:
8-12 dBv mitigation

Pandrol QTrack® with Alstom Catenary-free APS Ground Level Power Supply at Sydney, Australia

Technical Features

- The Pandrol QTrack® system is an embedded recycled rubber solution, which utilises a top-down installation method as well a bottom up method by having a gutter/channel in the slab track as shown below.
- The system allows adjustable stiffness level to achieve the specific attenuation levels required.
- Pandrol QTrack® Switches and Crossings system provides customised full elastic encapsulation of switches and crossings in prefabricated recycled rubber elements.
- The QTrack® system can also be designed and integrated in pre-fabricated concrete beams or slabs for a quick installation in projects, that require a minimum traffic disruption.
- It can be blended into the surrounding also with greenery grass mats:

LRT Kaohsiung – Taiwan on Green Pandrol QTrack

Advantages

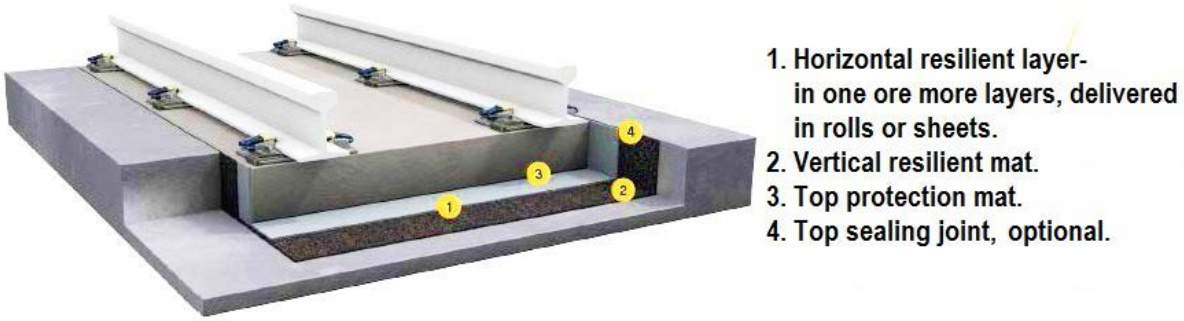
- Designed for rapid installation, QTrack® has an installation rate of up to 144 m/day/work-group.
- Rail corrugation is controlled due to homogeneous stiffness of the track, which results in less grinding activities (reducing maintenance and increasing track longevity) and lower vibration emissions due to better rail surface quality.

Pandrol has developed also a **Floating Slab Mat (FSM)**, which is a high-performing vibration attenuation floating slab system. It is easy to install, maintenance free and compatible with all types of rail and track systems.

The FSM is based on the mass-spring principle. The concrete slab (the mass) is elastically supported by a continuous resilient mat (the spring). The elastic properties of the mat solution are defined by track and train design, chosen material, defined thickness and number of layers and determined shape factor. They are made from high-quality resin-bonded rubbers.

The FSM has been proven to mitigate vibration transmission from rolling stock into neighbouring environments. Reductions of between 14 dB(v) and 25 dB(v) of recorded vibration levels are possible, ensuring that on most critical frequencies where vibration reduction is needed.

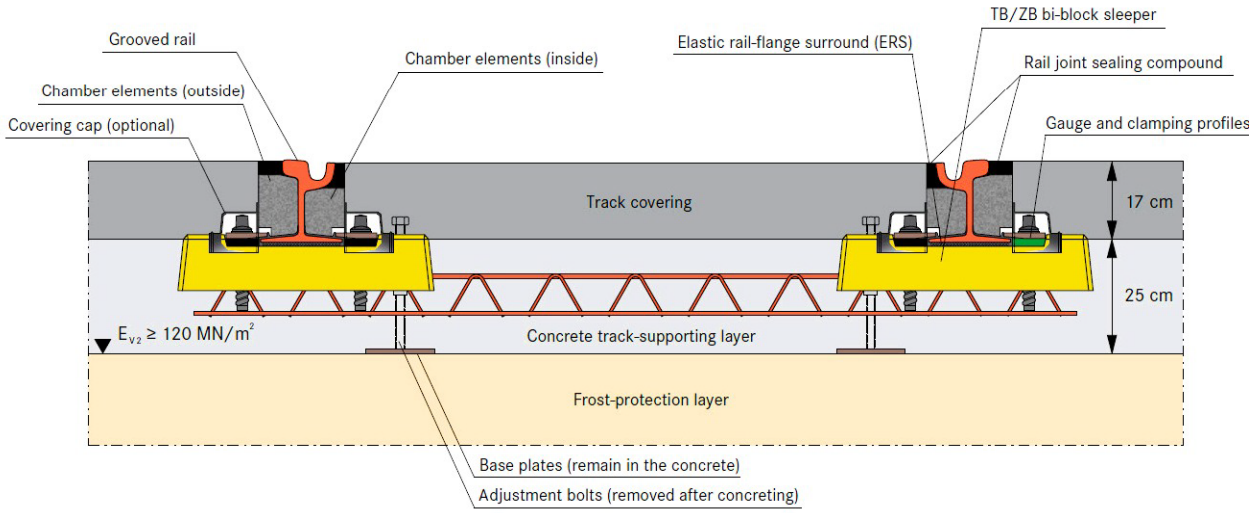
Insulation performance can be tuned by modifying the stiffness of the mat or the properties of the slab:



PANDROL floating Slab Mat, FSM

III. Ballast-less Tramway Track Assembly with Cross Ties/Sleepers

Several European cities (Dublin, Edinburgh, Warsaw, Utrecht, Den Haag, Cologne, Mannheim, Nuremberg, Seville and Granada) have preferred in recent times a Ballast-less Tramway Track Assembly with support on Cross-Ties/Sleepers. The **RHEDA CITY Tram-Track Assembly** consists of bi-block meter- or standard-gauge sleepers with lattice trusses and concreted into place with lattice girders to form a monolithic concrete track-supporting layer. The sleeper spacing is 75 cm. The rail webs get flanged with sound and vibration mitigating chamber elements. The result, depending on the track model, is either a system of elastic point support or of continuously elastic support of the rails:



Cross Section of Rheda City Tram-Track Assembly

The rail fastenings for the *RHEDA CITY* model are preassembled in the sleeper factory. In conjunction with the rail fastening systems, the sleepers create a specified track gauge. The adjustable rail fastenings compensate for any tolerance deviations. The track panel is measured at the top edge and at the gauge side of the rail, adjusted as necessary, and finally fixed into place. These measures produce an extremely high degree of precision and, later, an outstanding quality of track position and geometry. The track covering can be provided in several layers of asphalt, concrete or of paving blocks. The elastic rail joint sealing between the rail and the covering is provided in the form of special compounds. The elasticity of these compounds ensures that the sealing effect of the joint is not impaired by movements caused by rail operations:

Laying of RHEDA CITY Assembly with Standard Gauge Bi-Block Sleepers

Laying of RHEDA CITY Assembly with Meter Gauge Bi-Block Sleepers at Heidelberg, Germany

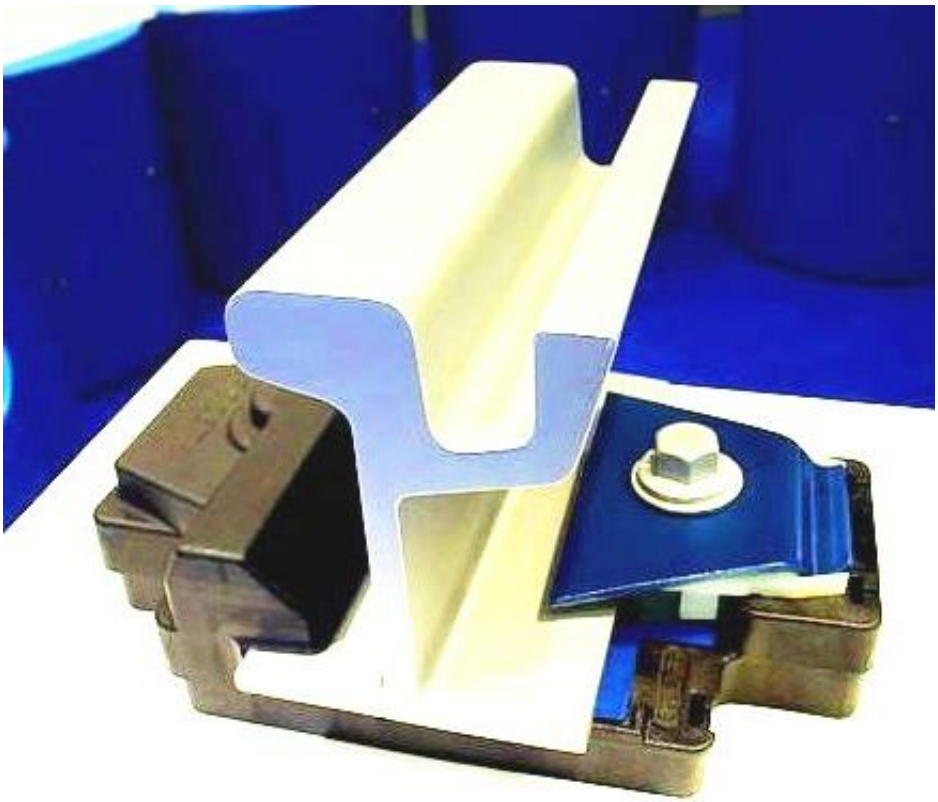
Installation of Web-Chamber Element

Road Integration with Top Asphalt Layer

For ***"Green Tracks"***, the track is filled with fertile soil and turf:

"Green" City Tram-Track on reserved Corridor

For Cross-Tie/Sleeper Tram Tracks **PANDROL** is providing a special damping vertical and horizontal adjustable Nabla rail to sleeper fastening:

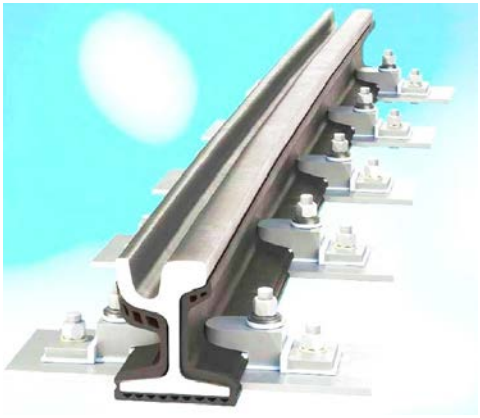


PANDROL Nabla-Tram direct Rail Fastening

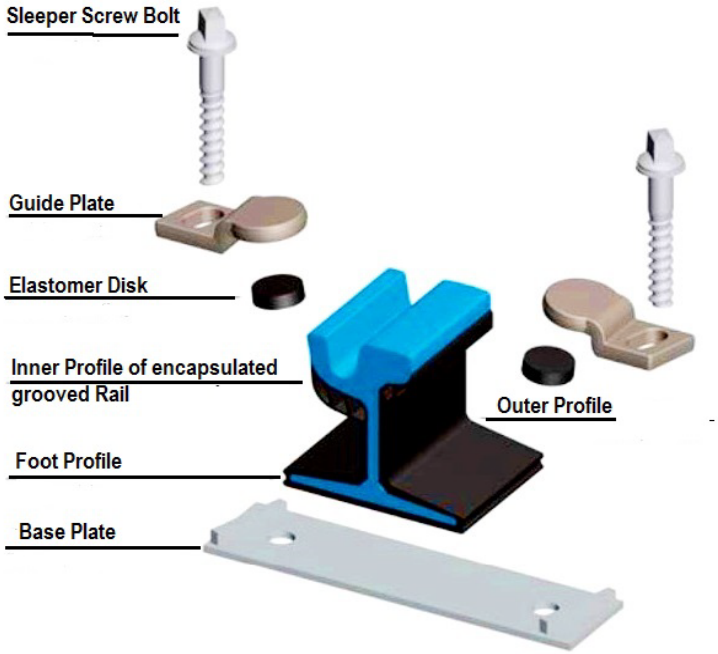
The Rail Fastening Provider **VOSSLOH** has in its portfolio a special direct Tension Clamp, SKI, rail fastener for City Tram Tracks, which isolates the rail from the ground by elastic polymer elements:

VOSSLOH W Tram SKI direct Rail Fastening

The Austrian world leader in manufacturing high steel quality rails and turnouts, Voest Alpine, has developed a special grooved rail to sleeper or slab-track fastening incorporation the elasticity not in the clamp, but in the screw fastening and bearing plate:



VOEST ALPINE indirect Elastic Tram Rail Fastening System *RHEINFEDER*, RF



Components of VOEST ALPINE *RHEINFEDER* Tram-Rail Fastening

Ground borne noise and vibration attenuation can be also achieved with wooden sleepers in a sand bed: