COLOMBO SUBURBAN RAILWAY PROJECT (CSRP) - an ambitious Project

Feasable and applicable technical Solutions

Current State of Sri Lanka Railway`s Affairs on Kelani Valley Rail-Track

Feasable and applicable technical Solutions presented by Dr. Frank Wingler, September 2018

Synopsis:

The project is aiming to create more demand for commuter rail transport by providing modern high capacity and rapid urban and suburban rail transport facilities.

Electrification of the sector Panadura-Veyangoda will become exorbitant expensive. The capital investment costs will stand in no economical relation to the savings gathered by running only the fraction of short distance trains by electric propulsion. Sri Lanka has not enough reliable power supply with enough redundancy to guarantee an un-interrupted electricity supply. The Colombo Suburban Railway Project (CSRP) and the Colombo Suburban Efficiency Improvement Project should therefore concentrate to bring the existing tracks in sound and healthy condition with a quality matching with an increased traffic load and speed. This will mean to go for a comprehensive track substructure rehabilitation, strengthening and broadening, to increase the route-capacity through a more favourable track layout with modern state-of-the-art technology for turnouts and crossings (especially in the corridor Fort and Maradana), and through a less complicated signalling system with train protection allowing shorter headways.

The rolling stocks have to be better serviced repairrd and maintained as well the train brake systems. For this much more capacity has to be provided as presently available.

With the provision of a reliable Mass Rapid Transit, MRT, System in the densely populated KV-corridor the share of commuter rail-ridership will increase, and this will create a higher demand for rail transport. With a high train frequency and a short journey time to and from the city centre more people will use a rail-shuttle service from the new Hub at Kottawa-Makumbura under construction. This target can be reached by making use of modern track and rolling stock technology on the given trace with some geometry modifications and some easements of tight curves. The track should be re-engineered as a Meter-Gauge track with Long Welded Rails (LWR) on Y-shaped Steel-Sleepers and not with Indian Broad-Gauge with concrete sleepers, which will need more space and create a higher curve-resistance for trains and thus reduces the permissible speed in the tight curvatures. Level crossings have to be eliminated; alone 51 between Dematagoda and KM Hub. However, this will become high costly and difficult to achieve.

Sri Lanka can learn a lot from the performance of other high capacity suburban and regional rail services on Meter-Gauge and on Narrow-Gauge from the advanced railways in Germany, Switzerland, Austria and Spain. An LRT on an elevated structure in the KV-corridor will become too expensive and difficult to perform, and hence uneconomical. It will be not needed.

The bottleneck at the Balana-Incline on the route to Kandy can be defused by strengthening and broadening of the formation and by a track with Long Welded Rails (LWR) on Y Steel-Sleepers. The section has to be secured by rock-stabilization and rock-slide preventing measurements, perhaps by protecting galleries as other advance railways do around the globe. The trains have to be equipped with well serviced, repaired, maintained, examined, tested and certificated dual-pipe and graduate release compressed air-brake system in combination with well serviced reliable dynamic loco-brakes.

Kottawa-Makumbura Multimodal Road-Rail Hub under Construction; Source: Achinita Indusara You Toube, Jan. 2018

CONTENTS

***"Once upon a Time"* at Ratnapura;** Pict. by Les Nixon

WITHOUT WELL BEARING FORMATION AND CLEAN BALLAST-BED NO STABLE RAILROAD
Poor Quality Rail-Tracks in Sri Lanka

By Dr. Frank Wingler, August 2018

Modern well ballasted High Quality, Rail-Track; Union Pacific "Sunset-Route", California, USA; Pict. by EK Verlag, www.eisenbahn-kurier.de

The Railway-Tracks of **Srilankan Railways** are a shining teaching sample that a long-lasting well aligned rail-track, matching the traffic load it has to carry, is not possible without a well drained and well bearing Formation, a thick Formation Protective Layer (FPL, "Blanket" or "Sub-Ballast") and a proper and clean Ballast-Bed. The memory for the track misalignments in Sri Lanka is mostly buried in the poor bearing, damaged or even missing formation. The biggest obstacle for the Colombo Suburban Railway Project, to make the track fit for faster and more frequent commuter service, are not the current 90 pound rails but the poor bearing, yielding and unstable formations, or even the missing formation, and the improper and poor ballasting. Envisaged long welded UIC 60 rails and electrification alone will not do the job. See: ***COLOMBO BACKS RAIL TO TAKLE CONGESTIONS*** by Keith Barrow, in International Railway Journal, August 2018, page 30, and ***SIGNS OF PROGRESS IN ISLAND REVIVAL***, by Rohan Gunasekera, in Railway Gazette International, August 2018, page 62; see also: ***COLOMBO SUBURBAN RAILWAY PROJECT (CSRP);*** www.csrp.lk .

Envisaged electrification will not bring alleviation for the current low route capacity and low train speed, if not the rail-tracks from Kalutara up to Negombo, Avissavella and Rambukkana will face comprehensive formation-reengineering, -rehabilitation and -strengthening, as well proper ballasting. The current poor quality rail-tracks on week and poor bearing formation need constant and costly maintenance and repair -

"nearly as every train goes" = former GMR Mr. Priyal De Silva - ; **see Fig. 1**:

Fig. 1: Typical poor Quality Srilankan Rail-Track with nearly no Ballast on poor bearing Formation; Pict. from Ceylon Railway Forum

Due to poor quality tracks, train derailments, especially on the Upcountry or Uva-Line, are frequent; **Fig. 2a/b**:

Fig. 2a: Train Derailments on Srilankan un-ballasted Rail-Tracks, especially on the Upcountry (Main) Line (Uva-Line) are frequent; Night Mail Derailment on un-ballasted Rail Track with Concrete Sleepers near Kotagala; Pict. by Daily Mirror

Fig. 2b: S11 Power-Set Derailment on poor ballasted Track of SLR Northern Line

On the poor ballasted and poor aligned “bumpy” SLR tracks on poor bearing formation the train-speed and the riding comfort are low.

Quotations for Fundamentals of Rail-Track Technology:

- A rail-track is only as good as what is underneath.
- Without well bearing and well drained formation (subsoil, subgrade, blanket) no stable rail-track.
- Water is the enemy of a rail-track.
- The longevity depends, if the water can be taken out and kept away from the track-bed.
- Ballast is the blood of a rail-track.
- Without a well dimensioned and clean ballast-cushion no alignment-stable rail-track.

Fig. 3: Cross-Section of a Rail-Track; Pict. by F. Piereder

What does Ballast do?:

Ballast is a key part of the track system.

- It supports and arrests the sleepers against both vertical and lateral movements under traffic load;
- it spreads the loading from the sleepers onto the formation;
- provides a drainage path for precipitation;
- it facilitates to adjust and align the geometry of the track.

Those tasks can only be fulfilled, if there is a 30 to 35 cm thick well packed and clean ballast cushion under the sleeper-sole, if the space between the sleepers is boxed up with ballast and if there is a wide ballast shoulder at the end of the sleepers.

On Long Welded or Continuous Welded Rail-tracks (LWR/CWR) without fishplate joints, the ballast has not only to spread the load equal on the formation to avoid formation damage, but has also to arrest the longitudinal forces created by expanding or shrinking rails with the temperature.

In Sri Lanka there is no much difference between hot and cold, and hence the rails develop only little expansion and shrink forces with temperature variation. Rails are clamped onto the sleeper base-plate by their weight and in addition by the clamping force of elastic rail clips. This means that if the sleepers are properly arrested in a proper and well packed/tamped and un-fouled ballast bed over a well bearing formation, fishing rail-joints with fish-plates are not needed. Up to a curve tightness of 7 Degree all the rails could be continuously welded by Alumino-Thermic (AT) welding or better by electric flash-but welding.

Presently only the IRCON refurbished and rebuild rail tracks from Matara to Kalutara and north of Omanthai are laid on a proper ballast-bed and therefore allow long or continuous

welded rails providing a better long-living alignment and reducing drastically the maintenance expenditures.

Wooden sleepers are elastic and therefore gentle to ballast and formation. The contact area between ballast stones and the sole of wooden sleepers is in the range of 30 to 35 % since edges of ballast stones can penetrate into the sleeper sole.

Concrete sleepers are rigid and not elastic. The contact area between ballast stone edges and the sole is in the range of only 10 to 12 %. Therefore concrete sleepers are unfriendly to ballast and formation. Modern railways provide nowadays concrete sleepers with a rubber under-sleeper pad prolonging the life-time of ballast up to 3 times and prolonging the tamping cycles; see **Fig. 4a/b:**

Fig. 4a: New laid Concrete Sleepers with Under-Sleeper Pads; Pict. by Getzner, Austria

Fig. 4b: Increased Contact Area with Under-Sleeper Pads; Sketch by Getzner, Austria

When replacing wooden sleepers by concrete sleepers the bearing properties of the formation components and the thickness of the ballast cushion have to be increased to compensate the loss of elasticity. If not done, ballast degradation and formation damage will be the result; see **Fig. 5:**

Fig. 5: Formation and Ballast Damage caused by Concrete Sleeper on poorly ballasted Track after Replacing Wooden Sleeper; UVA Railway; Pict. by F. Wingler

Trough steel-sleepers have the advantage that they tolerate a thinner ballast cushion with only marginal ballast shoulders, provided the trough is filled inside with clean and un-fouled ballast stones, which interlock for crib with the stones of the ballast-cushion. They do not tolerate, if they are laid without a proper ballast cushion on muddy and wet earth, as on the UVA Line in Sri Lanka; see **Fig. 6:**

Fig. 6: Result of Laying new Steel-Sleepers without clean Ballast on UWA Line, Rozella-Hatton; the “dancing and tilting” Steel-Sleeper crush the Formation Material into Mud and submerge; Pict. by F. Wingler

What does a Formation Protective Layer or Blanket doe and what happens if the Ballast depth is insufficient?:

There is a strong correlation between ballast problems and problems in maintaining good track geometry, alignment and quality.

For a single line broad-gauge rail-track the land to be taken should have a width of at least 15 m. In Sri Lanka this is mostly not any more possible due to landgrabs and enchroachements. The top formation should have a width of 7800 mm to enable a proper geometry of the substructure components. Between the top of the formation with a width of 7.80 m and the ballast-bed of 30 to 35 cm depth there should be a 25 to 50 cm thick Formation Protective Layer (FPL), also called Blanket or Sub-Ballast, of a fine grain rock material of a particle size distribution from 0.02 to 30 mm with a maximum at 4 mm. Suitable is an Aggregated Base Course, ABS, used also for road constructions. A Geotextile layer between the top formation and the FPL prevents ABC and formation material to penetrate into each other. The FPL has in addition the task to distribute the forces onto the formation avoiding formation damage; **Fig.7/8:**

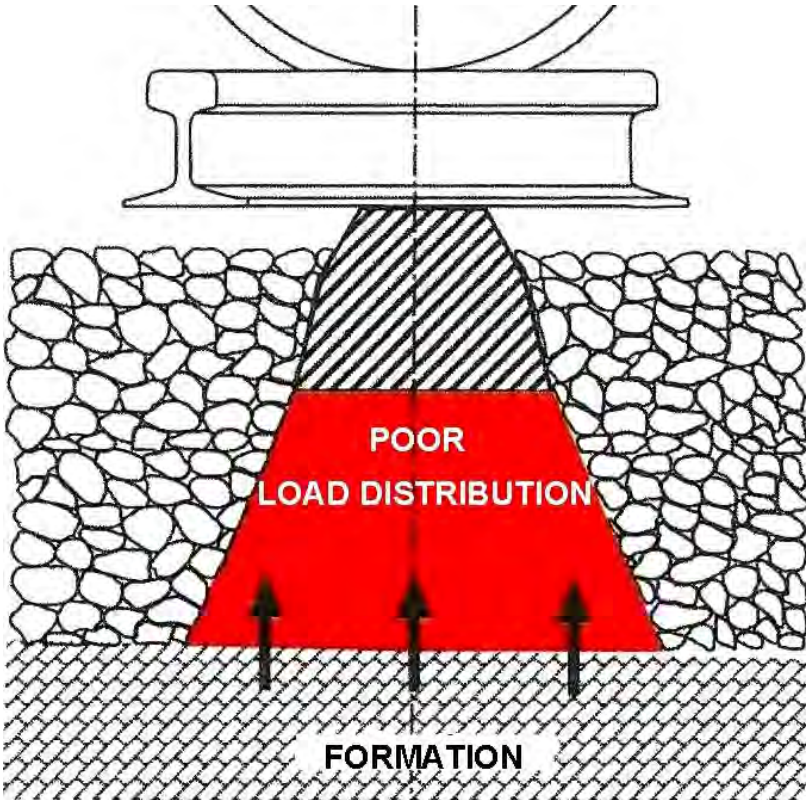

Fig. 7: Unfavorable Load Distribution and higher Formation Pressure on Track without Formation Protective Layer (FPL); Formation Material can penetrate into the Ballast Bed thus fouling the Ballast; Diagram by B. Lichtberger, Track Compendium

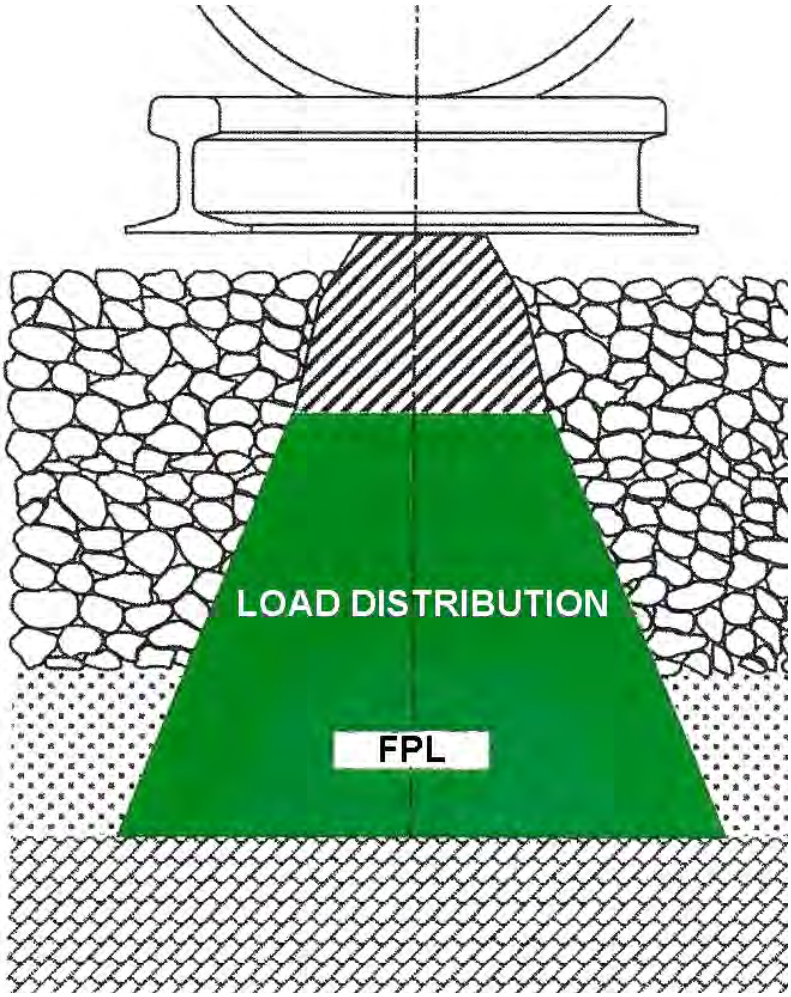

Fig. 8: A FPL spreads the Load on a wider Area and prevents Formation Material and Ballast from mixing; Diagram by B. Lichtberger, Track Compendium

If there is nearly no ballast or only marginal ballast and hence the Load Distribution not sufficient, the concrete sleeper will “dance” under dynamic traffic load, hammer the few ballast stones into the formation, formation material will prop up, and the marginal ballast stones get either crushed to dust or submerge in the formation. Overloading of formation due missing ballast and missing formation protective layer cause soil to penetrate into ballast vice versa. Formation material and ballast are mixing. This happens all over insufficient ballasted SLR Tracks. Water cannot be drained any more out and forms with the fouling materials a mud-slurry. Such tracks need high expenditures for “***maintenances nearly as every train goes”***; see **Fig. 9a,b/10/11/12**:

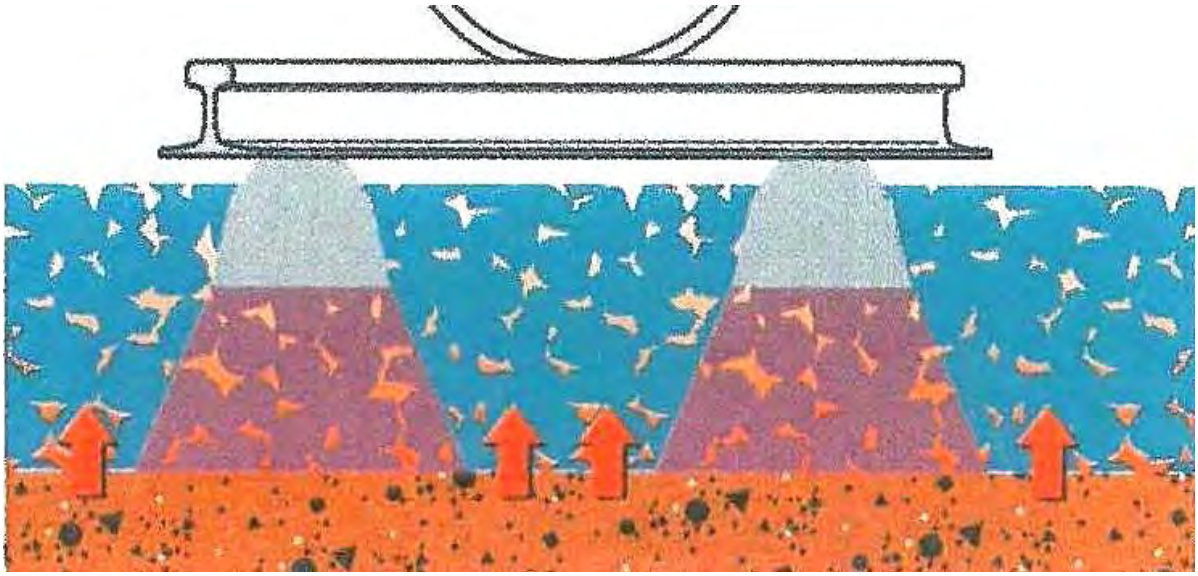

Fig. 9: Destruction of Formation and Fouling of Ballast due to insufficient Load Distribution with fouled Ballast; Diagram by B. Lichtberger, Track Compendium

Fig. 9b: Ballast and Formation-Material are mixing due to insufficient Ballasting and missing Formation Protective Layer, Pict. by Plasser&Theurer

Fig. 10: Result of insufficient Ballast Depth and fouled Ballast causing Formation Damage on SLR Track; Slurry rises up through the Ballast and Ballast-Stones submerge into the Formation; Pict. by F. Wingler

Loose and “dancing” concrete sleepers moving under traffic in an insufficient packed/tamped ballast-bed crush the stones to dust. In dry season such spots can be detected by white marks on the sleepers and rails; **Fig. 11a/b:**

Fig. 11a: White Marks on “dancing”/badly packed Concrete Sleepers caused by Ballast Abrasion

Fig. 11b:White Ballast Stones created by "dancing" Sleepers in poor packed Ballast-Bed: Pict. by IBES Baugrundinstitut GmbH

During rainy season the mud forms slurry and during dry season the mud gets cemented and creates dust. During dry season one can see SLR tracks "fuming" when a train runs.

Fig. 12: Typical "Mud-Pump" of "dancing Sleepers" on SLR Track; Pict. by F. Wingler

During rainy season the mud forms slurry and during dry season the mud gets cemented and creates dust. During dry season one can see SLR tracks “fuming” when a train runs.

Best Practice in Ballast and Formation Management/Maintenance:

Ballast must be kept clean and free from impurities, and the correct profile must be maintained.

Vegetation along the track (trees, bushes) fouling the ballast by falling leaves/foliages must be pruned or removed.

Advanced railways clean the ballast-bed in intervals after 4 to 10 years and replace of missing ballast; nowadays with heavy duty on-track ballast cleaning machinery; **Fig. 13a/b/c:**

Fig. 13a: Plasser&Theurer Ballast Cleaning Machine, RM 802; Pict. by Plasser&Theurer

Fig. 13b: Plasser&Theurer PM 200 2R on-Track Rehabilitation Train; Pict by Plasser&Theurer

Fig. 13c: Schematic Presentation of Track Rehabilitation Train; Sketch by Plasser&Theurer

A simpler tool to excavate contaminated soil, mud and fouled ballast is an Off-Track Under-Cutter mounted to a caterpillar backhoe-loader with an excavating under-cutting blade; **Fig. 14/15**:

Fig. 14: Off-Track Blade Under-Cutter, Hulder, USA; Pict. by Hulder

Fig. 15: Removing Mud and Muck from under the Sleepers with Off-Track Under-Cutter; Pict. by Hulder

For formation and blanket/sub-ballast rehabilitation modern railways use heavy duty and high performance on-track rehabilitation machineries; **Fig. 16/17:**

Fig. 16: Formation and FPL Rehabilitation with Geotextile through on-Track Machinery; Pict. by Plasse&Theurer

Fig. 17: Formation, FPL and Ballast Rehabilitation with on Track PM 1000 URM Machinery; Pict. by Plasser&Theurer

The top of a rehabilitated Formation Protective Layer (FPL) should have a slope of 1 in 20 to 1 in 40 to both sides in order to allow water to be drained to the sides; **Fig. 18:**

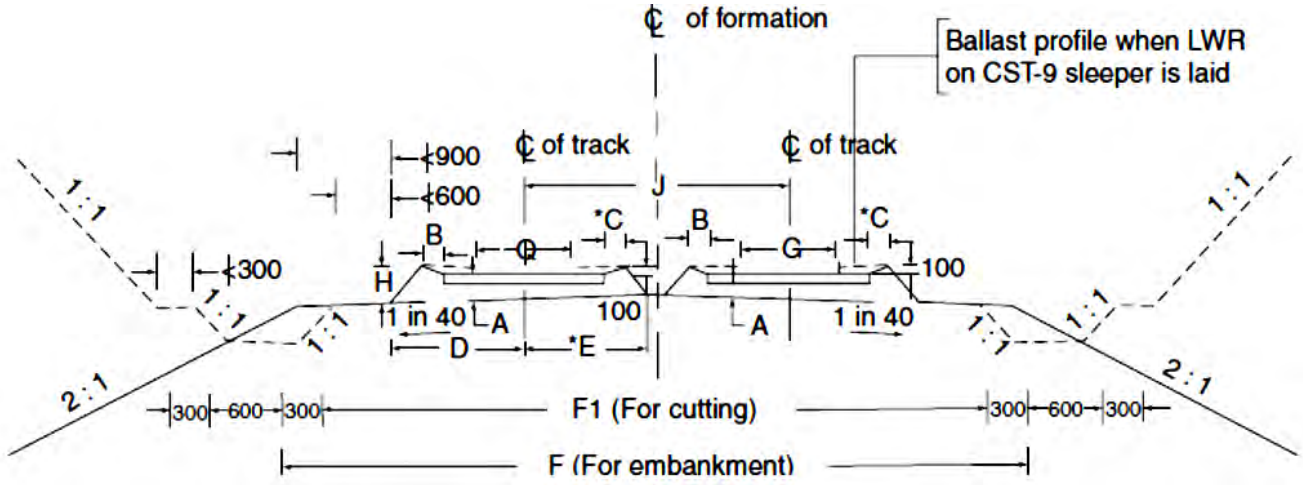

Fig. 18: Cross Section/Profile for a BG Double Track; Fig. by RDSO, India

Indian Railways have shown that in a traffic block of 4 hours 125 m of track can be completely removed, ballast and bad formation material excavated, core material (moorum) filled and compacted, a blanket and a fresh ballast cushion provided and finally the stabilized track re-laid; see **Fig. 19**:

Fig. 19: Formation Rehabilitation with conventional Off-Track Machinery under Traffic Block with complete Track-Removal; see paper No. 23 on ***Formation Treatment with Moorum….,*** presented by T. Anil Kumar, S. Veerama and U. Sarath on IPWE International Seminar, 23-24th Febr. 2018, at Guwahati, India

In lieu of such machineries ballast can also be conventional cleaned by manual “Deep Screening”, working from sleeper to sleeper; **Fig. 20**:

Fig. 20: Ballast Cleaning through manual “Deep-Screening”; Pict. by Andy Franklin, Carillion Rail, UK

For lifting, aligning and leveling and as well for packing of ballast on tracks, where there is a sufficient ballast depth, SLR has two computerized heavy duty on-track Plasser&Theurer Tamping Machines; **Fig. 21:**

Fig. 21: New Sri Lanka Railway Plasser&Theurer on-Track Lifting, Aligning and Tamping Machine; Pict. by Primal Madusanka

Hydraulic driven and vibrating tines pack the ballast stones under the lifted and aligned rails cum sleepers; **Fig. 22:**

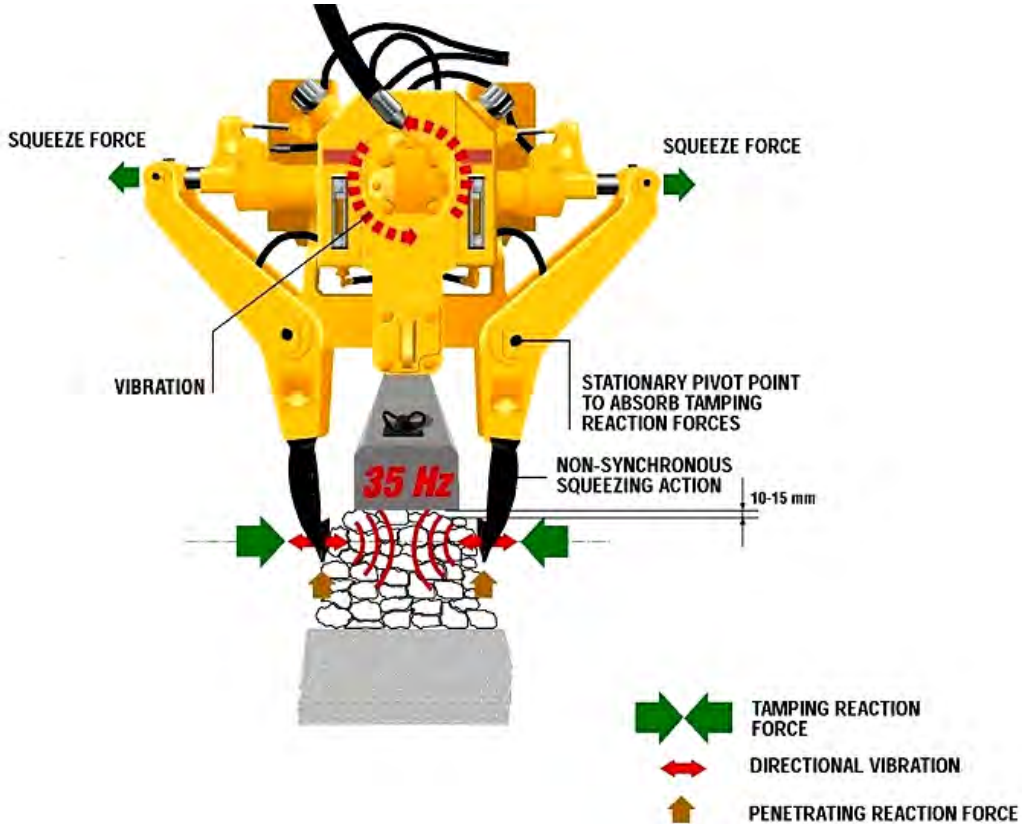

Fig. 22: Schematic Presentation of Tamping Tool Functions; Pict. by Plasser&Theurer

After tamping advanced railways consolidate the track with a vibrating Dynamic Track Stabilizer to allow using after aligning and tamping the track immediately with booked train speed. Through dynamic stabilization the stones get orientated in denser packing. Without dynamic stabilizer the consolidation by train traffic needs some weeks at reduced train-speed; **Fig.23/24**:

Fig. 23: Pl&Th Dynamic Track Stabilizer DGS 62 N; Pict. by Plasser&Theurer

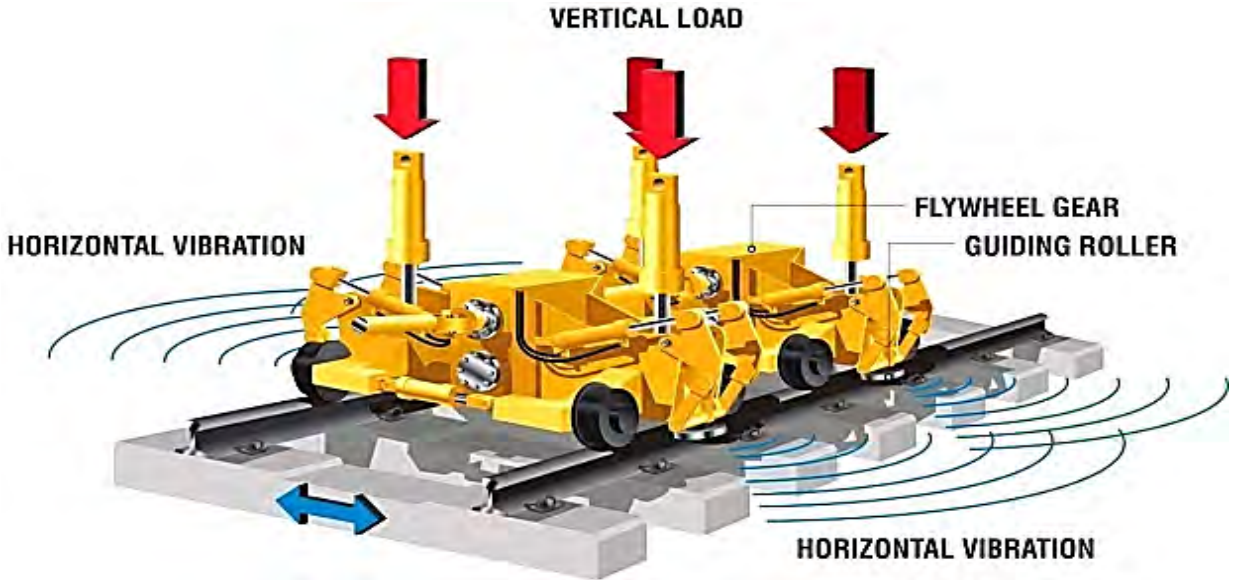

Fig. 24: Working Principle of dynamic Vibration Unit; Pict. by Plasser&Theurer

FAZIT: To be stingy with Ballast and Formation-Rehabilitation is not only uneconomical; it has also a disastrous Track destroying Effect, increases the Derailment-Proneness and causes high Maintenance Expenditure. Investment in Drainage- and Formation-Rehabilitation and in proper Track Ballasting is no Luxury. It cuts overall Life Cycle Costs, allows to increase the Train-Speed and Route Capacity, it increases the Safety and reduces the Derailment-Proneness. Formation reengineering and rehabilitation, drainage improvements, provision of formation protective layers and track ballasting should be given top priority in the envisaged modernization program for Sri Lanka Railways; see: Final Report on ***URBAN TRANSPORT SYSTEM DEVELOPMENT PROJECT FOR COLOMBO METROPOLITAN REGION AND SUBURBS, URBAN TRANSPORT MASTERPLAN***, Japan International Cooperation Agency, August 2014; Rohan Gunasekera ***SIGNS OF PROGRESS IN ISLAND REVIVAL,*** Railway Gazette International, August 2018, p. 62; see also website of the ***COLOMBO SUBURBAN RAILWAY PROJECT:*** www.csrp.lk, see page 21 **ANNEXURE**.

Fig. 26: The only Broad Gauge Main-Line Track around the Globe with Concrete Sleepers laid on a poor bearing Formation with nearly no Ballast Cushion; SLR Upcountry/Uva Line; Pict. by Ceylon Railway Forum

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"*Ballast-less Track Technology*" of Sri Lanka Railways on Main/Upcountry/Uva-Line

Pict. by F. Wingler

Pict. by F. Wingler

Actual Quality Level of Rail-Tracks in Sri Lanka

Unballasted Srilankan Main-Line Track on poor bearing and poor drained Formation at Ganemulla, unfit for a modern high Capacity and rapid Rail-Transport Service; Pict. by Google

Poor ballasted Srilankan Main-Line Track, unfit for a modern high Capacity rapid Rail-Transport Service; Pict. by Google

"*Ballast-less Track Technology*" of Sri Lanka Railways on Gauge converted Kelani Valley Line

Unfit for a modern Urban/Suburban Commuter Transport Service

Track Situation at Baseline Road Station, KV-Line; Pict. philipv203@gmail.com

KV-Line after Gauge Conversion; Pict by Google

KV-Line after Conversion from NG to BG, on a winding and narrow Trace with tight Curvatures unfit for a modern high Capacity and rapid Suburban Commuter Transport Service; Pict by Google

Negombo-Line in a deplorable State-of-Affairs, unfit for modern Suburban Rail Transport; Pict. by Google

"*Ballast-less Track-Structure*" on Main-Line at Kalaniya, Jan. 2018;
Pict. by Google

Sri Lanka Railway saves Pandrol-Clips; typical Situation on several Tracks

Target Quality of Rail-Track for Colombo Suburban Railway Project, CSRP

COLOMBO SUBURBAN RAILWAY PROJECT (CSRP); PART I
- an ambitious Project with a long Way between actual and Target Quality of Rail-Track

The Evolution of sound and healthy high Quality Tracks for Suburban Commuter Rail- Service

Electrified High Quality Rail Track fit for mixed Suburban and Long-Distance Train Service, Germany, near Frankfurt - a Track Quality Target for CSRP; Pict. by German Federal Railway,DB

By Dr. Frank Wingler, September 2018

PREFACE

In Sri Lanka, the majority of passenger transport is by road.

The ambitious Colombo Suburban Railway Project (CSRP) aims to increase the share of rail transport from the current 5% to 10%. The success of the project will depend on whether it will be possible to bring the dilapidated rail-tracks on sound and healthy high quality standards. The substructure of several railway-tracks is still at the level of the turn from the 19th century to the 20th century.

The upgrading of the railway-tracks will become the most difficult task within the programme. The technical paper deals with the current affairs, the role of the bearing substructure/formation and drainage, and it points out the tasks/ difficulties of strengthening, reengineering, revamping and upgrading.

High Quality Rail-Track in Ethiopia - a Track-Quality Target for the Srilankan CSRP Project?

COLOMBO SUBURBAN RAILWAY PROJECT (CSRP), PART I - an ambitious Project with a long Way between actual and Target Quality of Rail-Track

Looking at the Project through the Spectacles of Rail-Track Engineering and Technology

The Evolution of sound and healthy high Quality Tracks for Suburban Commuter Rail-Service

BACKGROUND

The Colombo Suburban Railway Project (SRP) was created on 7th of July 2016 with the commencement of Pre-feasibility Study in the Colombo Suburban Region of Sri Lanka Railway Network. Considering the Japan International Cooperation Agency , JICA, funded Colombo Urban Transport Master-Plan (ComTRANS) study carried out by the Ministry of Transport & Civil Aviation, and the Western Region Transport Master Plan prepared by the Ministry of Megapolis & Western Development, the Pre-feasibility Study of CSRP was focused towards passenger and freight demands for Sri Lanka Railways by 2025 and 2035. This included identifying requirement of Infrastructure Development, Passenger Needs, Hauling Power transition from Diesel to Electric, Business Processes etc. Now, the project has moved from pre-feasibility stage to detailed design stage. In this, construction of 105 km of additional tracks, rehabilitation of 210 km of existing tracks, development of railway stations and multi-modal hub-centres, replacing signalling system,

development of maintenance facilities and acquisition of new rolling stock will be considered and designed.

During this time, the interest of all sectors was focused to the Kelani Valley (KV) Line because this would ease off traffic congestions in Malapalla, Horana and Avissawella corridors.

Consequently, additional studies were entrusted to the Consultancy Team of M/s. egis International, France; a French engineering group involved in the areas of infrastructure and transport systems, planning, water and environment. Those were, Kelani Valley (KV) Line alternatives study and Long Distance Services of Railway. In addition, it was decided to carry out four or five of small scale projects, and the consultancy team prepared evaluation reports for those.

The Consultancy was completed and Draft Final Report was issued in November 2017. The Stakeholder Workshop was also held in November 2017.

The detailed design consultancy for the Development Initiatives identified by Pre-feasibility study was initiated in February 2017, and the procurement was completed, and the detailed design consultants were mobilized on 10.01.2018.

This was initiated through Asian Development Bank (ADB) loan of USD 10.0 million. The Scope of the consultancy was to carry out feasibility studies and detailed designs for

- Kelani Valley Line: Double track construction from Maradana to Padukka and single line rehabilitation from Padukka to Avissawella.
- Main Line: Four tracks from Maradana to Ragama, three tracks from Ragama to Veyangoda and double track rehabilitation from Veyangoda to Rambukkana.
- Coastal Line: Three tracks from Colombo Fort to Panadura and double tracki rehabilitation from Panadura to Kaluthara South.
- Puttalam Line: Two tracks from Katunayaka to Negambo and Airport. Rehabilitation of existing two tracks from Ragama to Katunayake.
- Development of railway stations to cater multi–model operation, park and ride and other facilities for public.
- Replacing signalling system of the entire project area, Colombo to Rambukkana, Colombo to Kalutara, Maradana to Awissawella and Ragama to Negambo.
- New Colombo Train Control Center (CTCC) with power control center for electrification.
- Electric multiple units with 6 cars having passenger capacity of 1200.

- Electrification Network consisting of grid sub stations, catenary & electric feeders.
- Development of existing maintenance (heavy and light) facilities for rolling stocks including maintenance sheds at Dematagoda and Maligawatte and workshops at Ratmalana. In addition, construction of level–1 andlLevel–2 maintenance sheds at Ratmalana, Maradana etc.

In addition to above:

- Detailed Design Consultants are to attend to: Surveys needed for engineering designs such as land surveys, topographic, hydrological, geological surveys etc..
- Social surveys and resettlement plans.
- Financial analysis of each development intervention.
- Training of railway engineers/officials.

The average speed on the Matale Line in KMR during peak traffic periods is around 25 kmphh. The poor track condition contributes to long delays. Sri Lanka Railway implemented a project to install Block Signalling in the section from Peradeniya to Kandy to reduce capacity limitations, which were experiencing during peak traffic, and then launched a project to double track on the section from Peradeniya to Kandy. The preliminary work is now in progress. SLR's plan is to improve the triangle section from Kadugannawa to Peradeniya, Peradeniya to Kandy and Peradeniya to Gampola. The objectives of the Kandy Suburban Railway Project are, to avoid the bottlenecks in the section from Kadugannawa to Katugastota, (possibly by double tracking), rehabilitate the section from Katugastota to Matale and to explore the possibility of increasing traffic capacity in the gradient section from Rambukkana to Kadugannawa.

The project will improve the capacity and operating speed of the railway network in the KMR by modernizing and upgrading track, signalling, communication and potentially electrifying the suburban railway lines to operate suburban train with electric traction. The project will also support procurement of fast and modern commuter trains, modernization of maintenance facilities, constructing new railway tracks and upgrading railway stations to improve intermodal connectivity, park-and-ride facilities at selected stations etc. The project will increase the capacity and attractiveness of the railway system, thus increasing its market share and reducing road congestion by shifting passenger preference to rail transport. The project will be designed on a modular basis to allow future expansions. The project will include three sub projects for:

- Double tracking the section from Kadugannawa to Katugastota,
- rehabilitating the section from Katugastota to Matale and
- a pre-feasibility study to explore the possibility of increasing traffic capacity in the gradient section from Rambukkana to Kadugannawa.

Present Status:

The Procurement for consultancy commenced in October 2017, and the Expression Of Interest (EOI) has been called. Twenty-one consultancy forms submitted their interests. The evaluation has now been completed and six shortlisted organizations will be issued with ***"Request for Proposal"*** documents. It is expected to mobilize consultants in June 2018.

= Source: http://www.csrp; ASIAN DEVELOPMENT BANK: ***Colombo Suburban Railway Project: Project Preparatory* Technical Assistance Report**, for download from https://www.adb.org/projects/49111-002/main ; ***Colombo Suburban Railway Efficiency Improvement Project (CSREIP),***
www.cabinetoffice.gov.lk/cab/index.php?option=com_content...id...,
EGIS: ***Colombo Suburban Railway Project,*** www.csrp.lk/images/pdf/Intercity-4.pdf .

DESIGNING OF RAIL-TRACK STRUCTURES AND WORKING PROCEEDURES TO UPGRADE EXISTING TRACKS

A main factor in this project will be the **DESIGNING** of the **RAIL-TRACK STRUCTURES** and the **WORKING PROCEEDURES** to make the current rail-tracks fit to match with the future traffic load, volume and speed.

High Quality Rail-Tracks with low deterioration rate under given traffic-load, -volume and -speed are a prerequisite for a modern **High Capacity Rail Transport System.**

Railways run with steel wheels on steel rails on a nearly inelastic and un-damped contact area of less than 3 cm^2. Elasticity has to be provided by the suspension of the rolling stocks and, following the Newton`s Law Mechanics, by the components or constituents of the rail-track in their entity. The components acting with each others, have to be fit to withstand the dynamic forces exerted by the running trains, their axle-load, speed and traffic volume.

There are two fundamental laws about the dependence of the **Inherent Track Quality** under given traffic load:

- A track is as good, as what is underneath: Substructure consisting of subsoil, subgrade, formation-materials, formation protective layer and ballast-cushion.

- The longevity and deterioration rate depend in a high extend, if the water can be taken out and kept away from the track bed.

This means, the track-quality, fit for the traffic load it has to carry, depends in a large extend on the well bearing **FORMATION** and **BALLAST BED** and as well on the **DRAINAGE**; see technical paper on "***WITHOUT***

WELL BEARING FORMATION AND CLEAN BALLAST-BED NO STABLE RAIL-ROAD; Poor Quality Rail-Tracks in Sri Lanka", free for download from the website: http://www.drwingler.com .

The technical quality of the current rail tracks are far away from modern standards. The alignments had been that time laid predominantly to transport plantation products from inland to the Colombo harbour by a light railway with steam locomotives of an axle-load of 12 tonnes – later of 14-16 tonnes. Several lines have been laid on earth instead on ballast, or had been laid on the plain ground. For the Main-Line from Colombo to Rambukkana all kind of available materials had been used to fill the embankments. Since long, the bearing capacity and stability (track support moduli) of the embankments and heaved up formations do not fulfil the requirements of the present traffic load and volume.

The specific tracks should be determined by their **TRACK SUPPORT MODULUS** in the unit [N/mm²] or [MN/m²] or [MPa], measured as deflection of the track under given load. According Prof. A. Kerr, ***FUNDAMENTALS OF RAILWAY TRACK ENGINEERING*****,** Simmons- Boardman, Books, Inc. Omaha, NE 68102, USA, ISBN: 0-911382-40-2, page 89, for a wooden sleeper track with dog spikes a Modulus of approx. 6 N/mm² is sufficient, whereas for a track with the stiff concrete sleepers the Modulus should be in the range of 40 N/mm². The stiffer concrete sleepers transmit to the sub-grade a higher pressure and may create sub-grade failures where none existing when wooden sleepers were used. This had not been considered, when SLR exchanged timber sleepers by concrete sleepers with the result, that formations got damaged further.

By physical laws the track stability, stiffness parameters and moduli have to be increased by 62%, if one wants to increase the train velocity from 80 to 100 kmph under the same traffic load. The necessary increase of stiffness and strength goes logarithmic with the velocity. With increase of the train speed not only the short wave length misalignments but also the long wave misalignments have to be rectified to a minimum of few millimeters

When rehabilitating the winding coast line from Matara to Kalutara South, IRCON had to make compromises because the grabbed railway land, which could not be anymore reclaimed, the tightness of the curvatures could not be eased and no proper surface water management provided. The line had been fully closed for month, the track superstructure dismantled, what had been left of the sub-structure had been compacted, a blanket or subballast layer with aggregated base course laid, a ballast cushion provided, in India manufactured concrete sleepers laid with flash-but welded rails composed of 13 m revised British standard 90 A rails, imported from AFERPI-LUCCHINI, Italy, and fastened with Indian RDSO designed MARK III Elastic Rail Clips (ERC). Due to irreversible land-grab a compromise had to be engineered

concerning the drainage with masonry walls functioning also as ballast retaining walls, but with the result, that in rainy season the water level in the track bed is sometimes higher than in the drains, leading to a memory-effect for coming up alignment defects.

Nevertheless, the result is much better than before. Trains now run smooth on the Long Welded Rail Track (LWR) with 60 to 80 kmph and on short straight sections with up to 90 kmph. But this is far away from what we are used from the quality of rail tracks in Central European Countries.

IRCON rebuild with the same technical features the Northern Line from Omantai to Kankesanturai and Talaimannar with the advantage, that the superstructure had been already dismantled by the insurgents during the civil war.

When SLR replaced the worn elastic dog-spiked timber sleeper by inelastic and heavy concrete sleepers with Pandrol Clip rail-fastenings, there had been no formation rehabilitation as required violating fundamental procedures of rail-track engineering with the result, that the formation got further damaged. And there is up to now no proper ballasting and no formation protective (blanketing/subballast) layer (FPL). The ballast bed is shallow, with the result that ballast stones mix with the formation materials and get lost in their support and stabilization of the sleepers. Despite frequent maintenance and repair works and tamping, the correct alignment cannot be kept. The alignment deterioration rates (loss of geometry under given traffic load over the time) are uneconomically high.

The low track quality and high deterioration rates slow down the train speed (on some lines to an average speed of 20 to 22 kmph) and make frequent and costly attendance by repairs and maintenance necessary ***"nearly as every train goes"*** (= press-release by former GMR Mr. Priyal de Silva).

Ailing un-ballasted Main-Line Rail-Track on weak and badly drained Formation at Ganemulla;
Pict. by Google

Negombo-Line laid on plain ground without bearing formation, Ballast and Side-Drains, unfit for the Colombo Suburban Railway Project ; Pict. by Google

TRACK QUALITY had been defined by the works and publications of the Technical University, Graz, Austria, Prof. P.Veit, and by Dr. B. Lichtberger, Plassser&Theurer. Advanced and modern Railways around the globe are following this wisdom about the advantage of **Track Quality under overall Life Cycle Costs Considerations**; see my technical railway papers published on the website http://www.drwingler.com.

If the **TRACK QUALITY** is not matching the traffic load it has to carry, the deterioration-rates (loss of alignment and geometry parameters under given traffic load) will be high, the train speed will decrease and the maintenance expenditures will increase by up to 8 times. This means, an envisaged train speed of 120 km and a high traffic load cannot be kept, if not the track with its substructure components and the drainage systems got adjusted.

All the existing SLR lines, which will be incorporated into the envisaged rail-traffic schemes, will need comprehensive reengineering, strengthening and rehabilitation of the substructure components; as well proper new drainage systems (surface as well undersurface).

Besides two Plasser&Theurer tamping machines, SLR has no other heavy duty and high performance on-track machinery for Ballast Stabilization,

Ballast Profiling, Ballast Cleaning, FPL-Laying and Formation Rehabilitation. The SLR work-procedures for track repairs and maintenances are far behind the European Methodologies of the 1950-ties (see handbook: ***FRANZ PIEREDER – EIN LEBEN FÜR DIE EISENBAHN***, PMC media house, Bingen, Germany, ISBN: 978-3-96245-150-9, 2017).

There are also no private track-infrastructure and rail-track managing companies, corporations or undertakings to do the rehabilitation job as in other advanced countries around the globe. With the available technology in Sri Lanka such required formation rehabilitation and drainage engineering will become a **severe bottleneck for the CSRP,** and it will become a high expenditure and labor intensive work under long line closures or long traffic blocks, hampering, disturbing and disrupting the current rail traffic for coming years

Malpractises committed in recent times:

- The single and dual rail-track from Ragama via Negombo to Putalam had been laid without any formation works on plain ground.
- For the recent line doubling from Panadura to Kalutara the track had been laid also on the plain strata without any drainage, formation, substructure components and ballast bed.
- The triple track from Demadegoda to Ragama had been laid on organic material containing earth embankment fill with the result, that despite frequent overhaul the alignment parameters cannot be kept and the train speed cannot be increased on this roller-coaster line over 50 kmph. To make use of this third track within a modern high capacity suburban rail traffic scheme, the line has to be closed, the track dismantled and the whole embankment material excavated and replaced by new core compacted material. As it is now, this third track is totally unfit for a modern high capacity suburban rail transport system.

One should be aware that the memory for track misalignments is mostly buried in what is underneath. **Weak and yielding formation cannot be compensated by stronger rails!**

- To construct the second track between Kalutara and Payagalla SLR took nearly 10 years with a poor result due to insufficient formation work. After few months in service, the author could observe that this new laid line is starting already to become warped. Persumably, the Srilankan Permanent Way Engineers, providing *“NON-PERMANENT WAYS*”, know, why they did not go for continuous welded rails on this poor bearing and narrow substructure, and why they laid only short gas-pressure welded rail panels linked with un-supported fish-plate joints, which started already to hog.

One should be aware that the memory for track misalignments is mostly buried in what is underneath. **Weak, yielding and badly drained formation, what cannot be compensated by stronger rails!**

For a modern single line track the land to be taken must have a width of 15 m and for a double line about 20 m. To reclaim lost railway land will become a difficult task.

The question had been left open, from where to take the lost railway land for a line doubling between Pyagalla South and Aluthgama in the section of Beruwela?, or for a line quadrupling and tripling on the main-line up to Veyangoda and for a line tripling on the Colombo urban section of the Coast Line.

Regarding the KV-Line, the Author has his own Opinion:

It had been a major mistake to convert the winding NG line up to Avissawella to Broad Gauge laying the BG track on the same winding trace without any formation work and to abandon the trace up to Ratnapura. On the tight broad gauge curvatures, with tightness of up to 18 degree, trains cannot run faster than 35 kmph. The poor quality track with its tight curvatures and without any stable formation and nearly no ballast allows no faster average station to station travel velocity than 22 kmph, which is much too slow for a modern urban and suburban Rapid Mass Transit System in the highly populated outskirt area. The trace from Avissawella to Ratnapura and the railway-land are once and forever lost and cannot any more be revitalized.

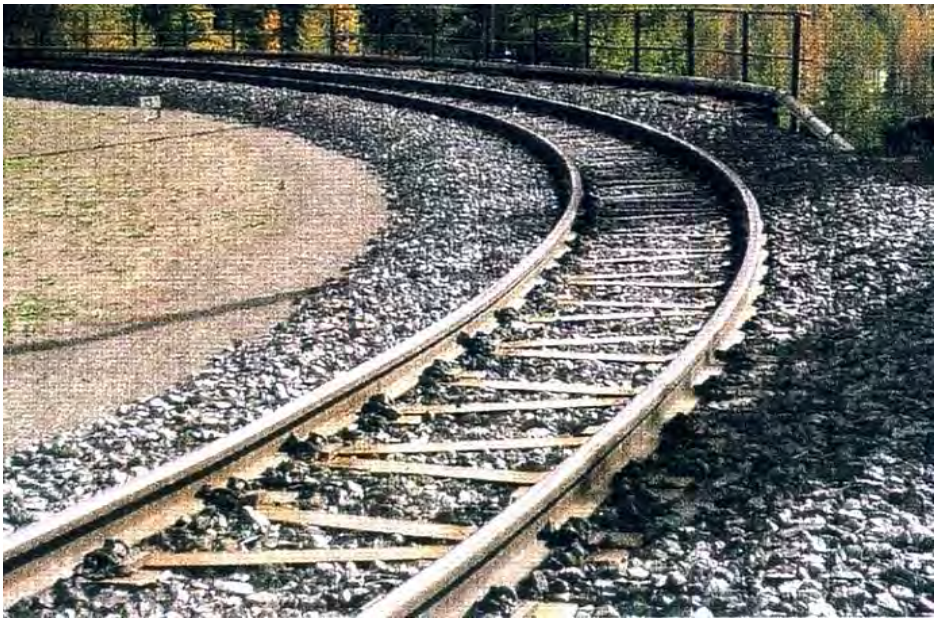
Ailing Tracks of KV-Line

KV-Line with a BG Rail-Track laid on the narrow Alignment of the former NG Trace without any Formation Engineering; Pict by Google

KV-Line with a BG Rail-Track laid on the winding and narrow Alignment of the former NG Trace without any Formation Engineering; Pict by Google

The KV-line terminates at Maradana and caters no long-distance through-traffic beyond. A gauge-brake would not have created trouble. The track should have been converted to **Meter Gauge (MG).** India has ample reconditioned meter gauge locomotives to be exported. Nowadays with **modern meter gauge light weight rail cars** and continuous welded rails on Y steel-sleepers laid on a well bearing formation and with sufficient ballasting, **MG Rail Cars** could negotiate the tight curvatures with over 60 kmph and on straight sections up to 120 kmph. Y steel-sleepers have the advantage that they tolerate a shallow ballast-cushion and a narrow formation top-width. Y steel-sleepers retain excellent the curve geometry. Y steel-sleepers allow even to lay on 45 meter (36.5 Degree) tight MG curves continuous welded rails. Switzerland has demonstrated on the Räthic Railway, what is nowadays possible on winding MG with Rail Cars of Swiss Stadler design and on tracks with ThyssenKrupp Schulte GmbH Y steel-sleepers:

THYSSENKRUPP Y Steel-Sleeper



Long Welded Rail (LWR) on 18 Degree, 45 m, Curve with Y Steel-Sleepers and without Curve Check-Rails on Bernina Railway, Switzerland

See: **Chapter 4.12.2** in the 640 page handbook by J.S. Mundrey/F.A. Wingler: ***INDIAN RAILWAY TRACKS – A TRACK ENGINEERING COMPENDIUM***, free for download from the website http://www.drwingler.com – under “PUBLICATIONS”.

In Sri Lanka, it will be not understood, why a MG track on the KV trace is advisable having many advantages compared with BG.

Stadler in Switzerland has engineered a 2 ½ feet NG railcar with middle traction module for Greece, which run for a test on a German NG track with 80 kmph. This demonstrates that for an urban and suburban commuter service the NG track could have been left on the KV trace.

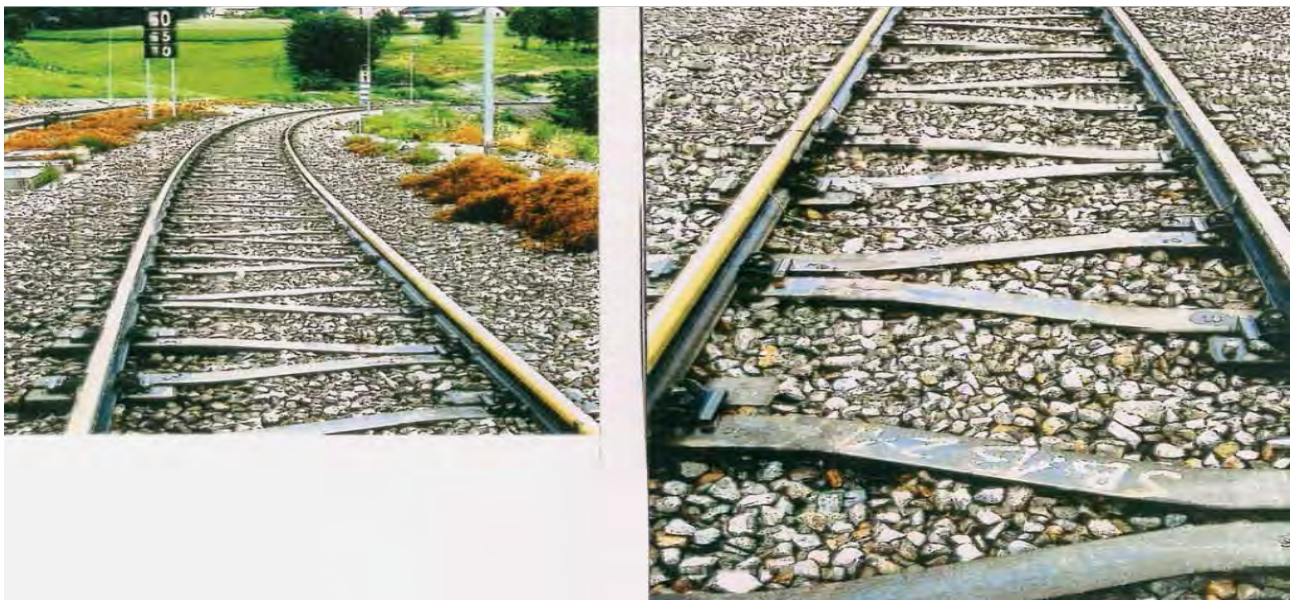
The value of the KV-trace is, that it crosses twice the Highway, at Malapalla and near Wattala/Enderamulla. The route of the highway has the disadvantage, that it touches only outskirts of Colombo, and the gain of journey time on the highway gets lost on the congested roads into or from the town. At Malapalla a highway-railroad hub intermodal road-rail station is under construction. Perhaps a second intermodal hub will come later at Enderamulla enabling to interlink highway bus service from and to the south with rail service from and to Colombo over the Main.Line.
On the current winding KV rail-trace with a poor quality track and a broad gauge without any proper well bearing formation and drainage system a rail shuttle service linking the Malapalla intermodal hub station under construction with the town centre will have only a low capacity and will be relatively slow. The Colombo Megapolis plan to bring a dual BG track on an elevated structure up to Malapalla will become highly costly and will need a lot of space. With Meter-Gauge the required space would be less and the task easier. See F. A. Wingler ***DESIGNING A LIGHT WEIGHT MODEL RAIL-CAR FOR THE "LANKA ECONO RAIL" PROJECT***; *published on: July 15, 2016 August 23, 2016,* free to download from http://www.drwingler.com .

As a Signalling System for the KV -ine one should think about the deployment of **COMMUNICATION BASED TRAIN CONTROL (CBTC)**; see https://www.cbtcsolutions.ca/about/

A bottleneck on the way to Kandy is the low route capacity of the Balana incline section between **Rambukkana and Katuganawa with its low permissible speed of 35 kmph**. This line is predominantly laid on the plain strata without a well bearing and well drained formation, formation protective layer and without any proper ballast bed. The whole substructure components and drainage systems have to be reengineered. For this winding section the most advisable sleepers will be **Y-shaped Thyssen/Krupp Steel-Sleepers**, keeping in a perfect way the curve geometry parameters. On a proper subgrade-structure with proper ballasting it will be technically feasible to provide **LONG WELDED RAILS** without fishplate-joints on **Y-Steel Sleepers**. But track upgrading under running traffic without mega-block will become a Herculean task. On such a track the speed could be increased from presently from 35 kmph to 60 kmph. A shining teaching sample for such a track structure is the winding 1 in 35 incline section of the VINSCHGAU Railway in

North Italy, on which Swiss Stadler build **Light Weight Rail-Cars** with middle Module Traction run up and down with 65 kmph.

Viceroy Special on ailing and weak Track **near** Lion`s Mouth, Balana Incline near Katuganawa; Pict. by curtesy of Bernd Sailer, from ***TAILS OF ASIEN STEAM***



ThyssenKrupp Y-shaped Steel-Sleepers on tight Curvatures of the 1 in 35 Incline Section of the Vinschgau-Railway, North Italy; Pict. by F. Wingler

When going for **Electrification** one should be aware, that with comprehensive formation rehabilitation or reengineering, with the provision of a formation protective layer (FPL) (sub-ballast, blanketing material) and with a proper ballast cushion = prerequisite for a viable rapid and high capacity/performance urban and suburban rail service = the existing rail tracks will come approx. 2 feet higher. This has consequences not only for the height of the catenary but also for over-bridges.

Electric traction needs a reliable power supply and an electric grid with enough redundancy in case of power plant failures. The envisaged section for electrification from Panadura to Veyangoda serves a mixed traffic scheme with long-distance and urban commuter trains. The long-distance trains will not harvest the benefits of electric traction. Even with electrification there will remain a mixed traffic scheme of Diesel and electric hauled or propelled trains. The slower trains will block the faster trains.

For track revamping, the KV-line up to Avissawella could be closed down for one year, and the current track superstructure could be taken out in order to provide a stable formation, proper drainage system, a formation protective layer and proper track ballasting, and as far as possible, to ease of the tightness of curvatures to less than 5-6 Degree. If the line has to be closed and the current rails and sleepers taken out anyway, the line could also be rebuilt in **Meter Gauge** offering many advantages. But latter will nobody understand in Sri Lanka, since it had become a sacrilege to challenge the 1676 mm Broad Gauge conversion under Priyal de Silva.

But the other tracks catering a mixed traffic schemes of suburban commuter trains and long-distance trains cannot be closed down for formation and drainage rehabilitation, unless temporary extra side tracks are laid. Otherwise track revamping has to be performed under traffic blocks. Upgrading will hamper and disturb the rail-traffic over years. Such difficulties and constraints should be properly taken into account in the relevant studies and plans

It will be a long, tedious and expensive way to make the existing lines fit for the Colombo Suburban Railway Project with High Quality Tracks. There will be a lot to do, starting with **comprehensive Formation Works**. The scope of necessary track-engineering works should not be underestimated.

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Handbook: J.S.Mundrey/ F.A. Wingler**,** ***INDIAN RAILWAY TRACKS - A TRACK ENGINEERING COMPENDIUM,*** http://www.drwingler.com ;

and the Technical Railway Papers published free for download on http://www.drwingler.com; especially the papers on: ***WITHOUT WELL BEARING FORMATION AND CLEAN BALLAST-BED NO STABLE RAILROAD, Poor Quality Rail-Tracks in Sri Lanka,*** p*ublished on: August 13, 2018 August 25, 2018 ;*

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KV-Line after Narrow-Gauge to Broad-Gauge Conversion

ThyssenKrupp Y Steel-Sleepers in Curvature and long-welded Rails of Meter-Gauge Suburban Commuter Rail-Service in Switzerland, S 17 Bremgarten-Dietikon, Canton Aargau

COLOMBO SUBURBAN RAILWAY PROJECT (CSRP); PART II - Learning technical Solutions from advanced Railways

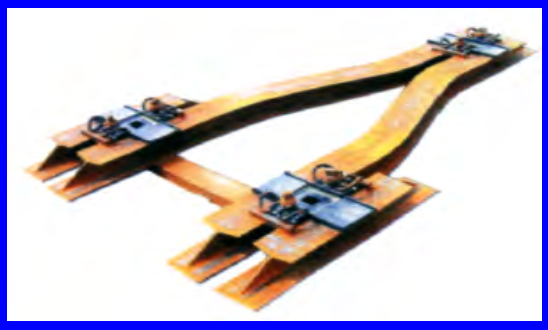
Regional Suburban Commuter Rail Service on Meter-Gauge Track of tight Curvatures with Y ThyssenKrupp Steel-Sleepers in Switzerland, Canton Aargau, Line S 17, Bremgarten-Dietikon

By Dr. Frank Wingler, September 2018

SYNOPSIS

Whereas Part I deals with the technologies and the difficulties of reengineering the existing tracks to become sound, healthy and fit to cater a modern high capacity Urban and Suburban Rail Transport System, Part II deals with technical solutions for the KV-Line and the Main-Line from Colombo to Kandy, especially for the Balana Incline between Rambukkana and Katuganawa, that can be learned from other advanced railways.

In order to increase the geometry stability in the tight curvatures with troublesome and narrow top-formation of the KV-Line and the Balana Incline, the author suggest making use of Thyssen/Krupp Schulte GmbH **Y-SHAPED STEEL-SLEEPERS** with Pandrol Fast Clip rail-fastenings and long welded rails. This track system is used in Italy, Switzerland and Germany for mountain and hill railways with tight curves and steep ruling gradients. Y steel-sleepers are advantageous on shallow ballast beds and narrow top-of-formation width and allow long-welded rails in tight curves. In curves, those sleepers provide the rail-grid with an excellent geometry stability.



ThyssenKrupp Schulte GmbH
Y-shaped Steel-Sleeper

A conversion of the KV rail-track to **METER GAUGE** would provide many advantages, especially allowing higher speed in tight curvatures on narrow formation. **METRE GAUGE CONVERSION** should be possible, since the KV ends at Maradana/Fort and carries no long-distance trains proceeding on other broad-gauge lines.

As **ROLLING STOCKS** the author suggests to make use of modern Light Weight Rail Cars of Swiss Stadler technology propelled by Diesel-electric power packs rating 2 x 800 KW in a middle traction van/module with a free gangway for the commuters, as the author has designed and envisaged for the **LANKA ECONO RAIL PROJECT**, initiated by L. Perera of Micro Cars Pvt. Ltd. Those Rail-Cars with middle traction run in Lithuania, Germany, Switzerland, Italy and Greece.

1 in 87 Model of Light Weight Rail-Car with middle Module Traction, System Stadler

COLOMBO SUBURBAN RAILWAY PROJECT (CSRP); PART II - Learning technical Solutions from advanced Railways

Case Study I: The Kelani Valley (KV) Railway Line

The upgrading of the KV Line is in the focus of the CSRP. The Kelani-Valley line runs southeast from Colombo Maradana Station, through much of the city and outskirts of Colombo. It runs through major business centers, like Nugegoda and Maharagama, before turning eastwards. It crosses the Southern Expressway near Homagama and continues east towards Avissawella, the current terminus of the line. The trace runs through an increasingly urbanising community, and if transformed to a modern Mass Rapid Transport Rail System it would ease off road traffic congestions in Malapalla, Horana and Avissawella corridors and serve as a fedder rail system between city center and the intermodal Southern Expressway hub at Malapalla.

The KV-line was originally laid as a 2 ½ feet Narrow-Gauge (NG) on a narrow and winding trace with tight curvatures up to 22 Degree (80 m radius). The laying of the narrow gauge railway commenced about 1900 from Maradana to Yatiyantota as the original Kelani Valley Railway through Baseline Road, Cotta Road, Manning Town, Nugegoda, Nawinna, Pannipitiya, Kottawa, Homagama, Migoda, Padukka, Waga, Kosgama, Puwakpitiya, Avissawella, Dehiowita, Karawanella covering a distance of 77 km (48 miles) and reaching Yatiyantota in 1903. The line titled the Pelmadulla Extension (part of the Kelani Valley & Sabaragamuwa Light Railway) from Avissawella reached Ratnapura in 1912 and Opanayaka in 1919 covering a total distance of 142 km (89 miles) and lifting the line to 140 meters above mean sea level. Although the whole of the narrow gauge railway network is mistakenly referred to as Kelani Valley, strictly the Kelani Valley was the section up to Yatiyantota. This narrow gauge line, spaced at 2 feet 6 inches with their quaint ‘baby’ trains, was initiated for transporting rubber and low/mid grown tea as well as raw graphite from the Bogala Mine. In the early days there was also high patronage of passengers especially during the Adam’s Peak pilgrim season.

However, the transport capacity and train-speed on the winding NG trace had been low and therefore, could not compete with road-traffic

In 1992, a project was started to convert the line to Broad-Gauge, 1,676 mm (5 ft 6 in), on the old NG trace without any formation, drainage and nearly no ballasting works. The project was finally completed up to Avissawella (58 km

or 36 mi) in 1996. The tracks beyond were completely dismantled leaving only ruined stations, bridges, and bunds.

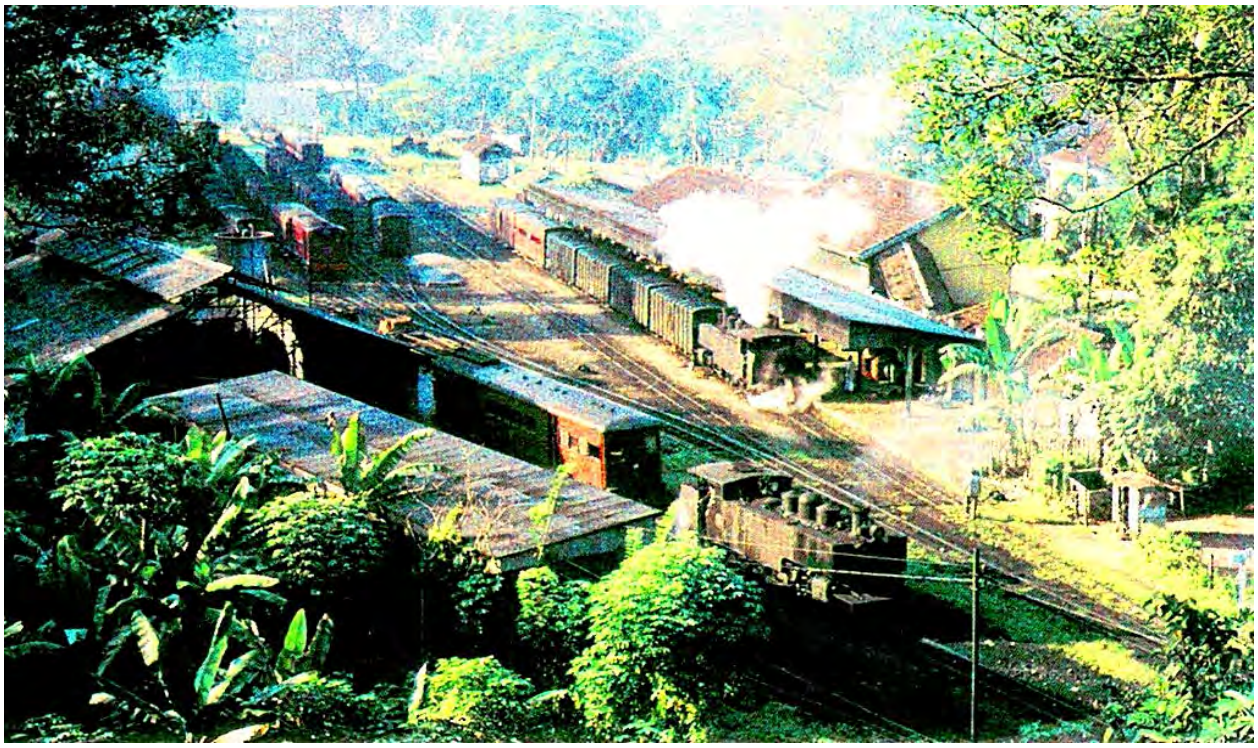
Down the **M**emory Line, Seetawaka Oya Bridge

Hunslet “Big KV” J1b Class, 4-6-4 T Tank, No. 292, Steam Locomotive, build 1929, on the winding NG KV**-**Line, in Service up to 1990

Rehabilitated Class V1 Chain driven Steam Railcar build 1927 by Sentinel, on the gauntlet BG/NG Track

Old Railway Bridge at Ratnapura

Wey Ganga Bridge at Opanayaka; now used for a Road



Down the Memory Line: Ratnapura Railway-Station 1974; now serving as Bus Stand; Pict. by Les Nixon

Current operating speeds on the converted BG single line are limited due to the tight curves of up to 17 Degree and the poor quality rail-track.

After dismantling the track, the railway-land via Ratnapura to Opanayaka have been used for widening of roads and some used as lanes by local authorities. But the majority of railway land fell under land-grab and encroachments. The land for a modern and advanced suburban rail-service it is now lost forever.

It had been a big mistake to convert from NG to BG on the same winding and narrow trace and to give up the trace and railway-land to Ratnapura. Since the line ends at Maradana/Fort, and since there is no through traffic for long-distance trains, the line could have been converted up to Ratnapura to Meter-Gauge under some easements of tight curvatures and after formation and drainage upgrading. This would have made things easier, and it would have

saved the trace to build a **Mass Rapid Transit Suburban Rail System up to Ratnapura.**

Warped KV Broad-Gauge Rail-Track on Narrow-Gauge Trace**, Baseline Road Station** – unfit for a high Capacity Urban and Suburban Commuter Rail Service

On Meter-Gauge track, it would have been nowadays possible to run a high capacity and fast commuter service with modern Light Weight Rail Cars, powered by so-called Diesel power packs, over tight curvatures laid on ThyssenKrupp Y-shaped steel-sleepers with 60 to 80 kmph instead presently with max. 35 kmph on Broad Gauge with heavy power-sets; see: F. A. Wingler ***DESIGNING A LIGHT WEIGHT MODEL RAIL CAR FOR THE "LANKA ECONO RAIL" PROJECT*****;** *published on: July 15, 2016 August 23, 2016,* free to download from http://drwingler.com ; and ***COLOMBO SUBURBAN RAILWAY PROJECT (PARTI)*** ibid..

The CSRP Management Team can learn from the high Capacity Meter-Gauge Networks and Regional Train Services in Switzerland.

A shining teaching sample amongst other Meter Gauge Railways is the regional **Dietikon-Bremgarten Railway** in Canton Aargau, Switzerland, negotiating curvatures as tight as 72 Degree (25 m radius) with Stadler build articulated and electric propelled rail cars, climbing over a gradient of 1 in 17.5. The curve long-welded rails are laid on ThyssenKrupp Y steel-sleepers.

The headway on the single track section is 15 minutes. After moderisation, this railway had been incorporated into the Suburban Rapid Transit Railway Network of Zurich as City Railway Line S 17. The ridership is now high.

Bremgarten-Dietigon Regional Rail-Service S 17 on MG with long-welded Rails on ThyssenKrupp Y Steel-Sleepers, Canton Aargau, Switzerland

Another success-story with **Light Weight Rail-Cars** (Diesel propelled) on traces with tight curvatures, ruling gradient of 1 in 35 and with ThyssenKrupp Y steel-sleepers is the rehabilitation of the Regional Standard-Gauge **Vinschgau-Railway** in North Italy. The rehabilitated and 2005 reopened railway runs from Meran to Mals. Originally the trace should be extended as an alpine traverse over the Ofen-Pass to Graubünden in Switzerland and Reschen-Pass to the Inn Valley in Austria. But the projects did not realize.
After modernization, the passenger volume exceeded all expectations. The railway serves in this region local population and as well holiday makers. The

rehabilitation and upgrading has boosted the local economy. Electrification is now envisaged.

Leaving Mals for a 1 in 35 down-gradient Run with 60 to 70 kmph on Y Steel-Sleeper Track

Winding Trace of Vinschgau-Railway, North Italy

ThyssenKrupp Y Steel-Sleepers at Mals, Vinschgau, North Italy

Stadler, Switzerland, build Light Weight Rail-Car with Middle Module Diesel-electric Traction **on Vinschgau-Railway, North Italy**

Rail-Track rehabilitated with long welded Rails on Y Steel-Sleepers **on Vinschgau-Railway, North Italy**

Case Study II: The Balana-Incline on the Route from Rambukkana to Kandy

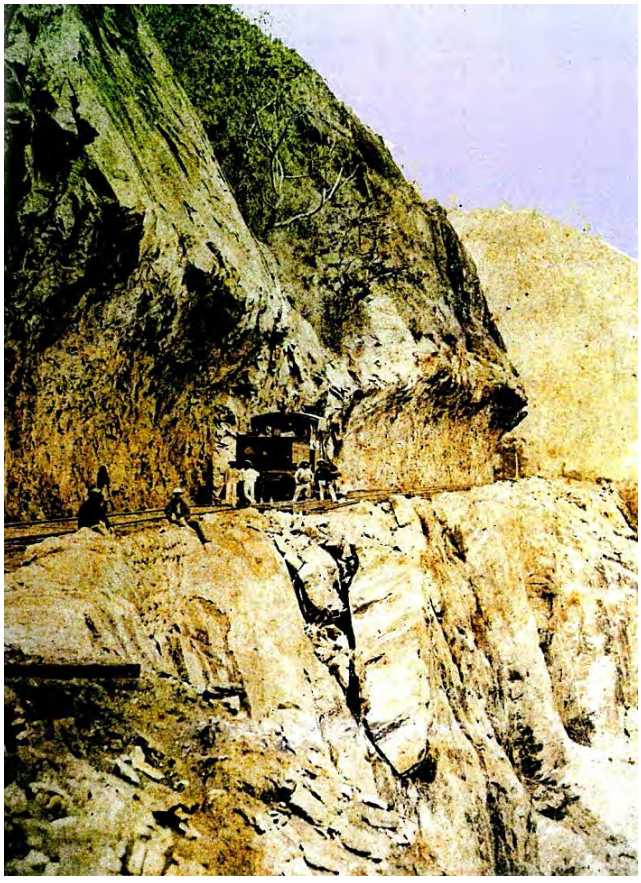
To travel by train from Colombo to Kandy on the Main-Line over a distance of 120 km takes 2 hours and 31 minutes with the fastest intercity train and with an average speed of 48 kmph. This low speed is owed to the poor track

quality of the double track main-line from Colombo to Rambukkana, the bottleneck of the single track on the Balana Incline and the inferior quality single line track from Kadugannawa via Peradeniya to Kandy. An upgrade making use of modern state-to-the-art Rail-Track Engineering and Technology would allow a speed between Colombo and Rambukkana of 110 to 120 kmph, on the Balana Incline of about 60 kmph and on the Kadugannawa-Kandy section of 80 kmph.

The economy in the Kandy region is rapidly developing. There is an increasing demand for daily journey.

On the 13 miles from Rambukkana to Kadugannawa over the Balana Pass the single track main-line rises 426 m with a ruling gradient of 1 in 45 (2.22 %). There are 12 tunnels and several tight 6 to 9 Degree curves. The line to Kandy had been opened 1867.

The track structure is nearly the same as 1867, only that instead of of-spiked timber sleepers there are now concrete sleepers with Pandrol Clips and heavier rails, however less ballast than in the 1870-ties.



Balana Incline Track under Construction in the 1860-ties at Sensation`s Rock (left) and Lion`s Mouth (right); Pict. from ***CEYLON RAILWAY HERITAGE***, by K.A.D. Nandasena and V. Wickremeratne; see also R.L. Dissanayake ***FASCINATION OF RAILWAYS***

Current State-of-Affairs on Balana Incline; Concrete Sleepers laid without any Formation Works, without boxing up with Ballast and on plain and narrow Strata

Viceroy Special at Tunnel near next to Lion`s Mouth on "*ballastless"* Rail Track; Pict. with curtsey by B. Seiler from ***TALES OF ASIAN STEAM***

As already pointed out in the previous papers, on the Main-Line over its full length from Maradana up to Kandy there is an urgent need of comprehensive embankment widening, substructure/formation and drainage reengineering, provision of formation protective layer and state-to-the-art of ballasting for a continuous welded modern rail-track. The outdated turnouts with the short straight tongue rails have to be replaced by modern turnouts with curved tongue rails on sets of sleepers with sufficient length as can be found nowadays on the IRCON rehabilitated and rebuild tracks. **What are rail-track standards in the backward countries Ethiopia and Kenya in East Africa should also be possible in the advanced country Sri Lanka:**

Modern well ballasted and drained Rail-Track in Ethiopia, East Africa

Construction of a World Class Standard High Quality Track for 120 kmph in Kenya

The weak track structure on the Balana Incline allows only a max. permissible speed of 35 kmph hampering the route capacity. Ideal would be ThyssenKrupp Y steel-sleepers, which tolerate a shallow ballast cushion, narrow top-formation width, and which retain the geometry of the curve rail-grid in an excellent way. They are laid nowadays on many winding mountain railway lines in Central Europe. As fastening system the author proposes Pandrol Fast-Clips, as already used in Sri Lanka on recently laid Indian trough steel-sleepers of the Uva-line from Nawalapitiya to Pattipola and on some trial concrete sleepers on the KV-line.

On the Balana incline the top formation width has to be widened, and where not possible, ballast retaining walls provided. The side-drains and the catch drains have to be reengineered. Here one can learn from the Kothavalasa–Kirandul (KK) hill Railway passing through the three states Andhra Pradesh, Odisha and Chhattisgarh in India; see: Dr. F.A. Wingler ***WATER THE ENEMY OF THE RAIL TRACK***, published on: September 4, 2016 on http://www.drwingler.com :

Ballast retaining cum Drainage Walls on the Kirandul-Koraput Hill Railway in India

This well ballasted and most scenic line climbs through the hill sections of the Eastern Ghats through the Araku-Valley. This is the highest climbing broad gauge line in India. The line has a total of 58 tunnels and 84 major bridges, and some tunnels are as long as 520 metres:

Well maintained and serviced modern **Diesel power-pack powered Light Weight Rail Cars** would negotiate on a Y steel-sleeper track the Balana Incline up and down with about 60 kmph increasing the route capacity and cutting the journey time. The Author had designed for the ***"Lanka Econo Rail"*** Project (initiated by Micro Cars Pvt., Dr. Lawrence Perera)) on basis of Swiss Stadler technology a crashworthy (according European Crash Norms) Rail Car with a B0`B0`middle traction module and a free gangway for passengers through the module or power-van, latter can be used also as a "mini-loco"; see: F. A. Wingler ***DESIGNING A LIGHT WEIGHT MODEL RAIL-CAR FOR THE "LANKA ECONO RAIL" PROJECT*****;** *published on: July 15, 2016 August 23, 2016,* free to download from http://drwingler.com :

Design Study in 1 in 87 Scale of a B0`B0`Module powered Light Weight Rail-Car for the *"Lanka Econo Rail Project"* based on Swiss Stadler Traction-Module **Technology**; designed by Dr. F. A. Wingler

A modern track-structure with Y steel-sleepers would allow using the Balana-Incline with higher speed, if there is not the indigenous problem of Sri Lanka Railway with the improper maintained, serviced, repaired, tested, examined and certificated train-brake systems. **Defective train brake systems** are often addressed only when they appear during train run and not before. Vacuum and compressed air brake tests and certifications before commencing a train run, as prescribed and compulsory in India, are in Sri Lanka either unknown or unused.

There had been several run-away incidents with narrow escape on the incline. The worst run-away disaster happened in January 2002 due to brake-system failure and wrong-handling by train driver and guard of the Kandy-Colombo Intercity Train. On the last right-hand curve before entering the straight line to Rambukkana the coaches left the weak un-ballasted track together with the rail-grid at an estimated speed of over 110 kmph and tumbled into a soft paddy field. How many passengers got killed had been never exactly revealed. Not confirmed reports speak about 40 killed passengers. The Author had been that time called to render his contributions to the investigation committee:

Rambukkana Train Accident due to faulty Train Brake, January 2002;
Pict. by F. Wingler (left) and The Island (right)

RESUME OF TECHNICAL SOLUTIONS:

For KV-Line:

- Conversion to Meter Gauge.
- Broadening of Trace.
- Easement of Curves tighter than 6-7 Degree.
- Comprehensive Subgrade/Formation and Drainage Re-engineering, Top-Formation Width Broadening.
- Provision of Formation Protective Layer (FPL)/Subballast/Blanket.
- Full Profile Ballasting.
- ThyssenKrupp Y Steel-Sleepers with Pandrol Fast-Clips on Curves.
- Modern Points/Turnouts with curved Tongue Rails on Sets of Point-Sleepers.
- Long welded Rail Track (LWR).
- Communication based Train Control (CBTC).
- Light Weight Rail Cars powered by Power-Packs of Swiss Stadler Traction-Module Design.

For Main-Line up to Kandy:

- Broadening of Trace.
- Comprehensive Embankment Broadening, Subgrade/Formation and Drainage Re-engineering, Top Formation-Width Broadening.
- Provision of Formation Protective Layer (FPL)/Subballast/Blanket.
- Full Profile Ballasting.
- ThyssenKrupp Y Steel-Sleepers with Pandrol Fast-Clips on Balana Incline.
- Modern Points/Turnouts with curved Tongue Rails on Sets of Point-Sleepers.
- Long Welded/Continuous Welded Rail Track (LWR/CWR).
- Deployment of Automatic Train Protection System.
- Strict Supervision and Control of Train-Brake System: –Repair, -Maintenance, -Examination, -Testing, strict to follow and compulsory Schedules/Procedures for Brake-Examination, -Testing and Issue of

Brake-Certificate before dispatching for Train Run through Train-Driver, Head-Guard and Brake-Examiner (as stipulated and compulsory in India).

Y-shaped Steel-Sleepers on winding Bernina Railway Meter-Gauge Track with 45 m Radius Curves and Long Welded Rails

Last not Least; SLR Main-Line, Upcountry Section

OUTLOOK

Bird`s View on Kottawa-Makumbura Multimodal Transport Hub under Construction; KV-Line

Kottawa-Makumbura Hub Railway-Station under Construction

COLOMBO SUBURBAN RAILWAY PROJECT (CSRP); PART III - Focus on KV-Line and Balana-Incline; Concept with Meter-Gauge and Y Steel-Sleepers

Meter Gauge Rail-Track on elevated Structure with ThyssenKrupp Y Steel-Sleepers and Long Welded Rails (LWR) in Spain

By Dr. Frank Wingler, September 2018

COLOMBO SUBURBAN RAILWAY PROJECT (CSRP); PART III - Focus on KV-Line and Balana-Incline; Concept with Meter-Gauge and Y Steel-Sleepers

Current Affairs on converted Broad-Gauge, former Narrow Gauge, KV-Line Track

Although it will become a long and tedious way to reengineer and transform the KV-Trace to become sound and healthy matching a state-of-the art high capacity Mass Rapid Transit Suburban Commuter Rail-System, the CSRP should first of all concentrate on and focus towards the implementation of the KV-Project target.

It will become not easy to resettle all the encroachers, to reclaim the railway land, to acquire new land for line doubling (at grade or on elevated structure) and for easing the tight curvatures to not tighter than 6-7 Degree.

With the hub for multi-modal operations under construction at Kottawa-Makumbura, a first step has been taken.

It will make it easier, that, for the upcoming engineering works, the KV-line can be fully closed down over a lengthy period, and since presently there is not much rail-traffic on this trace.

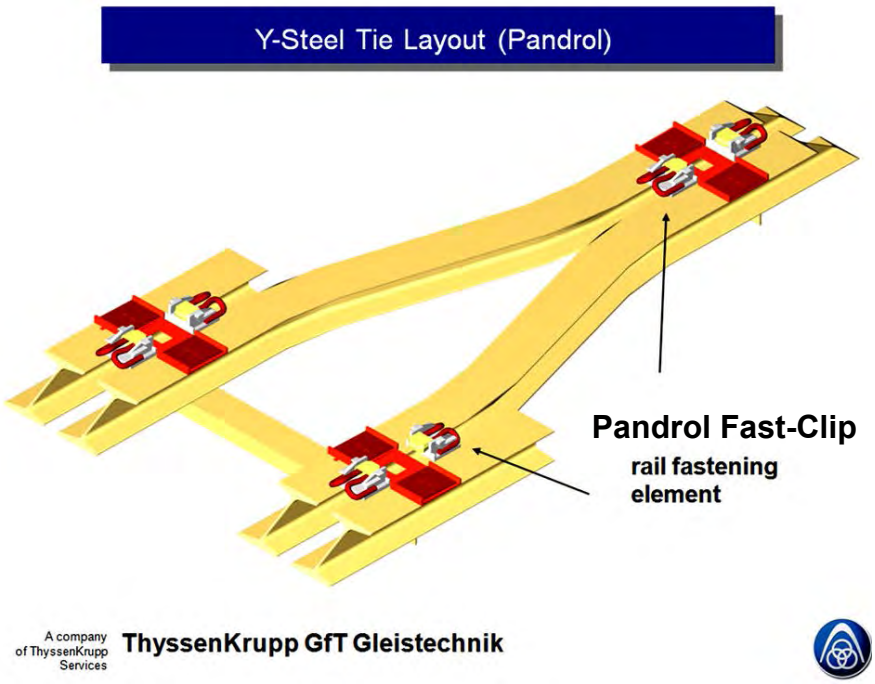
In contrast, the other lines, envisaged to be up-graded within the CSRP, cannot be closed down, and reengineering has to be executed under traffic or under short traffic blocks. To make matters worse, on Sri Lanka there are no heavy duty and high performance on-track rehabilitating and reengineering machinery trains as in other advanced countries. On the section Panadura - Slave-Island - Fort there is not enough space for an envisaged third

track; see image page 8. The current poor bearing and yielding formation/embankment of the third track between Dematagoda and Ragama is unfit for the envisaged project. The yielding substructure components have to be removed, and a new broader and well bearing embankment/formation has to be engineered. For the envisaged track quadrupling on the troublesome marshy subsoil of the Dematagoda-Veyangoda section **Ground Reinforcement** with geogrids will be essential. Line quadrupling on this marshy land will need additional technological foundation and stabilizing measurements; see image page 8.

CSRP Animation of Multi Modal **Transport** Hub on KV-Line Kottawa**-**Ma**kumbura**

Rail-Track Rehabilitation **by** On-Track Machinery Train

I strongly advocate to upgrade the KV-Track on **Meter-Gauge** with **Y-shaped Steel-Sleepers, with Long Welded Rails (LWR) and Pandrol Fast-Clip Rail Fastening**, providing several advantages over a Broad-Gauge track with concrete sleepers and Short Welded Rails (SWR):



Less space is needed. Y steel-sleepers tolerate shallow ballast cushion and allow a tigher top-of-formation width. They make the track-grid resistant to the socalled “curve breathing” in curves without the need to heap up ballast shoulder as needed for concrete sleepers, and they retain the curve geometry parameters in an excellent way.; see: J. Franz, ***CURVE BREATHING AND TRACK STABILITY OF Y STEEL-SLEEPER TRACK WITH TIGHT CURVES*** in EI, DER EISENBAHNINGENIEUR, 55, December, 2004; Eurailpress Fachartikelarchiv, www.eurailpress.de/archiv ; see also ***THE Y-STEEL-SLEEPERS IN SWITZERLAND (DIE Y-STAHLSCHWELLE IN DER SCHWEIZ),*** PDF, www.os.cd.cz/.../09_Strolz-a86acb4f5feb06b3cae87daea0611d08 .

Y steel-sleepers are nowadays widely used especially on mountain railways and by railways with tight curvatures and narrow traces in Switzerland, Austria, Italy, Spain and Germany. The live-span is longer than of concrete sleepers with less maintenance expenditures as demonstrated on a 160 kmph standard gauge test-track between Cologne and Düsseldorf in Germany.

On elevated structure, as envisaged for the KV-line, **Meter-Gauge** and Y steel-sleepers demand less space, and with less ballast-cushion there is less weight. Modern Light Weight Rail-Cars have higher acceleration and deceleration rates than conventional Power-Sets like the Class S8, S9, S11 and S12 with heavy Diesel-engines in power cars, and they can faster negotiate tight curves.

Y Steel-Sleepers on Meter-Gauge Track on elevated Structure of rehabilitated Montserrat Railway Spain

Meter-Gauge Stadler Diesel-electric Module Light Weight Rail-Car for Urban/Suburban Commuter Rail-Service in Greece on Test-Run in Switzerland; Pict. by Peter Walter

Modern high Capacity Suburban Rail Transport System on Meter-Gauge with Y-shaped Steel-Sleepers and Long Welded Rails (LWR) on winding Trace, making Use of Ballast retaining Walls, with Stadler Light Weight Rail-Cars; Canton Aargau Switzerland

See also: ***DESIGNING A LIGHT WEIGHT MODEL RAIL CAR FOR THE "LANKA ECONO RAIL" PROJECT,*** **p**ublished on: July 15, 2016 August 23, 2016 on http://www.drwingler.com .

Micro Cars Limited in Sri Lanka has made efforts to develop Rail Mass Transport Systems in Sri Lanka using Light Weight Rail Car Concepts in order to design and manufacture in Sri Lanka Diesel engine powered Rail Cars under the ***"LANKA ECONO RAIL"*** Project. Dr. F. Wingler designed a Rail Car based on the technology of the Swizz Rail Car Manufacturer Stadler with conventional "Diesel Power-Packs" in middle Traction Unit. For Crash-Worthiness, Dr. F. Wingler suggested for the Driver`s Cabins the Stadler Concepts fulfilling European Crash Norms. Two 1 in 87 scale train-set models have been displayed in October 2014 at a Technical Railway Exhibition held at the Richmond College, Galle, Sri Lanka:

1 in 87 Scale Design Study for "*Lanka Econo Rail*" Light Weight Rail-Car with a B0`B0`Midddle Traction-Van with inside free Passage for Travelers

Stadler Module Light Weight Rail-Cars for Suburban Rail-Service in Austria

Stadler in Switzerland is renowned for customer tailored solutions. The module rail-cars can be coupled to longer units according the demand of the hour of day. The arrangement of the traction power-packs with up to 2 x 800 kW in a traction-module or traction container makes maintenance easy. For the Lithuanian Railway Stadler has built a special B0B0 four axle Broad-Gauge traction module for rougher rail-tracks.

For the rehabilitation of the ailing Balana-Incline Broad-Gauge rail-track with Y steel-sleepers, one can learn from the complete re-engineering of the Montserrat Railway in Spain, which underwent in 1991 renovation under trace broadening using concrete retaining walls:

Track Re-engineering in Spain on narrow and winding Trace of Montserrat Mountain Rack-Railway with Y Steel-Sleeper, Long Welded Rails and Formation/Ballast Retaining Walls – a shining Sample for Re-engineering the ailing BG Balana-Incline Track in Sri Lanka with Y Steel-Sleepers

Shining Sample for Main-Line Rehabilitation and Upgrading Dematego da-Veyangoda: Ground/Embankment Reinforcement with TENSAR Geogrid on troublesome Subsoil of a Line Quadrupling Project in England; Pict.by TENSAR International GmbH, Germany

Not enough Space for third Track on Coast Line; Pict. by Google

A Target Track-Quality Standard for the CSRP: State-of-the Art Standard-Gauge double Line Rail-Track matching a modern high Capacity Suburban Rail Transport System with 140 kmph Diesel powered Light Weight Rail-Car, Regional Hessenbahn Railway RB 92, Germany

The power point presentation on CSRP ***"Project to enhance SUTI in Colombo Metropolitan Region (CMR)***" presents an animation of the Kottawa/Malapalla Hub. It is suggested to get also an animation designed on the ***VISION OF A SOUND AND HEALTHY RAIL-TRACK FOR A HIGH CAPACITY MASS RAPID TRANSIT RAIL-TRANSPORT SYSTEM ON THE TRACE OF THE KELANI VALLEY LINE***.

Indian Railways **TRACK STANDARDS for TRACK RENEWAL & REHABILITATION** are laid down in **Chapter 13, 14 and 18** of J.S. Mundrey/F.A. Wingler: ***INDIAN RAILWAY TRACKS – A TRACK ENGINEERING COMPENDIUM,*** free for download from http://www.drwingler.com, and in **Chapter 13, 14 and 18** of J.S. Mundrey: ***RAILWAY TRACK ENGINEERING***, 5th Edition, 2017, McGraw Hill Education (India), Chennai, ISBN (13): 978-93-5260-648-1/ISBN (10): 93-5260-649-3; see also the reference list below.

Indian Railway`s Designs and Standards should be followed and used when implementing the Colombo Suburban Railway Project (CSRP) in Sri Lanka!

For the implementation of the KV-Line project the management-unit of the CSRP should lay down design parameters and specifications for:

- Ruling Design-Speed of 80 kmph, resp. of 60 kmph on tight curvatures.
- Max. Tightness of curvatures (not tighter than 6-7 Degree).

- Width of Land-to-be-taken for Double- and Single-Track incl. the Land needed for Drainage System.
- Width of the top-of-Formation for Double- and Single Track.
- Bearing Capacity of Formation in [MN/m²]; E_{v1} and E_{v2} Parameters for Soil-Formation-Materials in [MN/m²].
- Max. Axle-Load in [t].
- Specifications and Design-Parameters for Track Constituents/Components (Meter- or Broad-Gauge).
- Measurements for Headways of < 8 Min. for Shuttle Service between Fort and Kottawa/Malapalla Hub, ~ 15 Min. up to Padukka and ~ 20 Min. up to Avissawella.
- Acceleration- and Deceleration-Rates of Rolling Stocks in [m/sec²].
- Minimum dispatchable Traction-Effort for Rolling Stock per Weight of Train-Set in [kN/kg].

The author suggests for the KV Mass Rapid Transit System the deployment of Communication Based Train Control System (CBTC) or European Train Control System (ETCS) Level 1.

It will be highly appreciated, when the content and message of this letter can be forwarded to the relevant clients involved with the project works.

COLOMBO SUBURBAN RAILWAY PROJECT (CSRP); PART IV METER-GAUGE ON KV TRACE - FEASIBLE?

Once upon a Time with Narrow-Gauge on KV-Line

By Dr. Frank Wingler, September 2018

COLOMBO SUBURBAN RAILWAY PROJECT
Meter-Gauge on KV-Trace – feasible?

Once upon a Time with 2 ½ ft Narrow-Gauge on KV-Line

The author is aware that his suggestion to operate a modern rail-transport system on the KV-trace in **Meter-Gauge** will not meet with much approval amongst Srilankan experts as they hope, once to extend the KV-line from Padukka via Ratnapura and Embilipitiya to Hambantota.

The extension project via Embilipitiya has no chance to become reality, because to build such a connection will become too expensive and also uneconomical. The hilly terrain between Padukka and Ratnapura and between Kahawatte and Thimbolkatiya will create immense costs and will become a major engineering challenge. But even if such a project should be once realized, why not with Meter-Gauge, which will make things cheaper and easier!

Other countries have shown that there is nothing wrong to operate a railway with two different gauges. On advanced European Railways **Meter-Gauge** and even 760 mm **Narrow-Gauge** for suburban commuter services are by far not outdated.

In North Spain, RENFE operates a modern 1250 km **Meter-Gauge network** for urban/suburban and even for long distance trains although the main trunk lines are in Iberian Broad Gauge.

Spanish RENFE-FEVE Meter-Gauge Network in Cantabria (green/yellow: Meter-Gauge, red: Iberian Broad-Gauge)

RENFE-FEVE Diesel Light Weight Rail-Car Composition on Meter-Gauge for Suburban Commuter-Service **in North Spain**

Meter-Gauge "*TRANSCANTABRICO"* Luxury Train in North Spain

Where Meter-Gauge meets Broad-Gauge, tracks, turnouts and crossings can be laid in dual gauge as a gauntlet track. Rahee Industries, India, is specialized in providing track-technology for gauntlet tracks in Bangladesh:

Mixed Meter-Gauge/Broad-Gauge Gauntlet-Track Technology by Rahee Ind. in Bangladesh

Bangladesh operates successfully on a **mixed Indian Broad-Gauge – Meter-Gauge** rail-network.

Besides the Standard-Gauge network, Switzerland has **860 km Meter-Gauge Network** in operation, and is still investing heavily in upgrading and expanding the Meter-Gauge network by building new and re-engineering existing long alpine tunnels and by investing in new modern light-weight rolling stocks.

Zermatt – St. Moritz Glacier Express on Meter-Gauge, Switzerland

Harz Meter-Gauge Railway, Germany in 2018

In Germany the Harz-Railway operates a 140 km suburban, an intercity and also a tourist railway successfully on hilly and mountainous terrain on Meter-Gauge, and nowadays even still with modern steam locomotives; although the main network in Germany operates with Standard-Gauge.

In East Germany there are still several Narrow-Gauge (NG) (760 mm, 2 1/2 feet) railways for commuter-service as well for tourist-operation running. For peak hour commuter-service the Doellnitz Railway got recently from the Austrian Ziller-Valley NG Railway a new Light-Weight Diesel Rail-Car.

Modern NG Light Weight Diesel Rail-Car for Commuter Service **for NG** Doellnitz Railway in Germany, on Test Run in Austria on the 760 mm NG Ziller-Valley Railway

Austria operates successfully several **760 mm Narrow-Gauge Railways**. The 32 km long Ziller-Valley NG railway transports per year 2.5 million passengers. The question had been to electrify the line. The decision went in favour of powering the rail-cars in future by **HYDROGENE** fuel cell technology:

Stadler designed Rail-Car for Commuter-Service on 760 mm Narrow-Gauge dual Track Ziller-Valley Railway in Austria, prop**ulsion w**ith Hydrogen Fuel Cells**;** Animation by Stadler Bussnang

The longest **Narrow-Gauge** railway in operation in Austria is the 92 km Mariazell-Railway from St. Pölten to Mariazell near Vienna:

For suburban commuter service this NG railway got modern Light Weight Rail-Cars build by Stadler:

Modern High Capacity Suburban Commuter Service on 760 mm Narrow-Gauge with electric Light Weight Rail-Car on renovated Mariazell Railway, Austria

Stadler Bussnang, Switzerland has recently built a modern 760 mm Narrow-Gauge Diesel-electric rail-car with middle power module traction for OSE, Greece. This 80 kmph fast vehicle had been tested in Germany on the recently renovated NG track of the Öchsle-Railway; see also F.A. Wingler: ***DESIGNING A LIGHT WEIGHT MODEL RAIL CAR FOR THE "LANKA ECONO RAIL" PROJECT,*** published on: July 15, 2016 August 23, 2016 on http://www.drwingler.com :

Stadler build NG Light Weight Rail-Car with middle Power Modul Traction on Test Run on rehabilitated 760 mm NG Rail-Track in Germany, 2007, Pict. by A. Schatz, Ulmer Eisenbahnfreunde

The ailing SLR Broad-Gauge Main-Line from Rambukkana to Badulla cannot be gauge converted for Meter-Gauge, although **Meter-Gauge** would have many advantages and would have made things easier on the narrow trace with tight curvatures. However, on the KV-trace a gauge conversion to **Meter-Gauge** should be possible and feasible.

The CSRP program should be implemented in steps, and one should concentrate first of all

- on establishing a modern high capacity suburban commuter rail-transport system on the trace of the KV-line (in Meter-Gauge and Y steel-sleepers) with Light Weight Rail-Cars, and
- on re-engineering the Balana-Incline from Rambukkanna to Kadugannawa with Y-shaped steel-sleepers, rock-stabilization, rock-fall and slop-slide protection under formation broadening for train-speed increase.

The second step should be deploying and implementing modern and state-of-art rail-track technology on the lines and designing new high capacity track-layouts for the stations on the corridor PANADURA-VEYANGODA in order to increase route capacity, train-speed cutting journey times between the stations, and to shorten headways through modern signalling and train protection systems. Electrification can come later, after the upgrading works for tracks and station-layouts have been completed.

ELECTRIFICATION is presently not feasible because

- there is not enough reliability and redundancy of power supply,
- the capital investment needed, and compared with the energy and maintenance savings gathered through running only a part of the trains electrically, will become exorbitant high.

The problems of ***Rail-Traffic in Sri Lanka*** are not related to the question: ***"DIESEL- OR ELECTRIC TRACTION".*** They are related to the ailing rail-tracks and inferior track quality engineering standards cum low-capacity layouts of stations with turnouts and crossings of outdated technology. The problems are also related to the poor repair, service and maintenance of rolling stocks.

Upgrading and re-engineering of the ailing tracks on poor bearing narrow and badly drained formation and renovation of track-layouts at stations for higher traffic capacity through modern technologies should come first before financing electric traction.

Once upon a Time with Steam on Narrow-Gauge in Sri Lanka;
Kelani-Valley Railway

Modern Diesel Commuter Rail-Car on Narrow-Gauge in Austria;
Ziller-Valley NG Railway

References:

Handbook: J.S.Mundrey/F.A. Wingler, I***NDIAN RAILWAY TRACKS - A TRACK ENGINEERING COMPENDIUM,*** http://www.drwingler.com;

and the Technical Railway Papers published free for download on http:// www.drwingler.com; especially the papers on: ***WITHOUT WELL BEARING FORMATION AND CLEAN BALLAST-BED NO STABLE RAILROAD, Poor Quality Rail-Tracks in Sri Lanka,*** published on August 13, 2018 August 25, 2018; and

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