LANKA ECONO RAIL (LER) PROJECT, AN ADVISABLE SOLUTION FOR SRI LANKAN RAILWAY CONSTRAINTS

By Dr. Frank Wingler, April 2014

1 in 87 Scale Model of a Lanka Econo Rail Car with Middle Traction Module

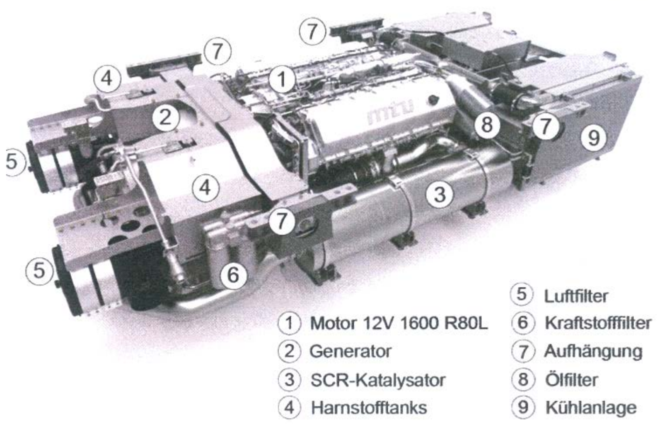
Dr. Lawrence Perera, the Manufacturer of **MICRO CARS** in Sri Lanka, initiated and promoted the Project **LANKA ECONO RAIL** for economical rail-solutions. He proposed to build with technical assistance from Germany in Sri Lanka **LIGHT-WEIGHT RAIL CARS (LWRCs)** by using his skills in the technology to build buses.

LIGHT–WEIGHT RAIL CARS, so-called *“LIGHT RAIL VEHICLES”* (LRV), electric or Diesel propelled, instead of conventional Locomotive hauled Trains, are the modern economical solution for Passenger Rail Transport. In European Countries. In UK they have replaced Locomotive hauled trains on most of regional lines. In UK there are no conventional locomotive hauled passenger daytime trains any more.

The Diesel-Versions have a hydro-mechanical gear-transmission known from heavy Lorries and for higher power-ratings a hydraulic transmission or an electric transmission. The fastest running **LIGHT–WEIGHT RAIL CARS** have electric transmission. The tilting Virgin-Pendolino Trains in England run with over 225 kmph, based on Siemens-Technology. Each coach is driven by a synchronised under-floor Power-Pack (see **Pict. 2: Picture Gallery**):

Pict. 2: Diesel-electric Rail-Car Trainset with Underfloor Power-Pack Tracktion; Virgin Train, UK

The bodies are of steel or aluminium integrated constructions. The Diesel-versions are propelled by conventional heavy road-vehicle Diesel-Engines, arranged under floor (see **Pict. 4; Pict. Gallery**) inside the carriages or mounted on the roof. There are standardised so-called **"Power-Packs"** at hand in the power-rating range from 340 to 900 hps (CUMMIN, DEUTZ, MAN, MTU) fixed with the auxiliary equipments on a frame (see **Pict. 3; Pict Gallery**):



Pict. 3: MTU 900 hp Power-Pack

The Diesel-Engines based on Road Vehicle Technology are more fuel efficient and exhaust less pollution. Service, maintenance and repair are easier. With less weight the vehicles are faster accelerating and decelerating. Less weight means also less Track Distortion.

A LIGHT–WEIGHT RAIL CAR is a track-friendly, less power consuming and therefore more economical solution cutting Overall-Life-Cycle-Costs; the Costs over the Life Cycle of Rolling Stocks <u>AND</u> Rail Tracks. The Life-Cycle is approximately 40 years.

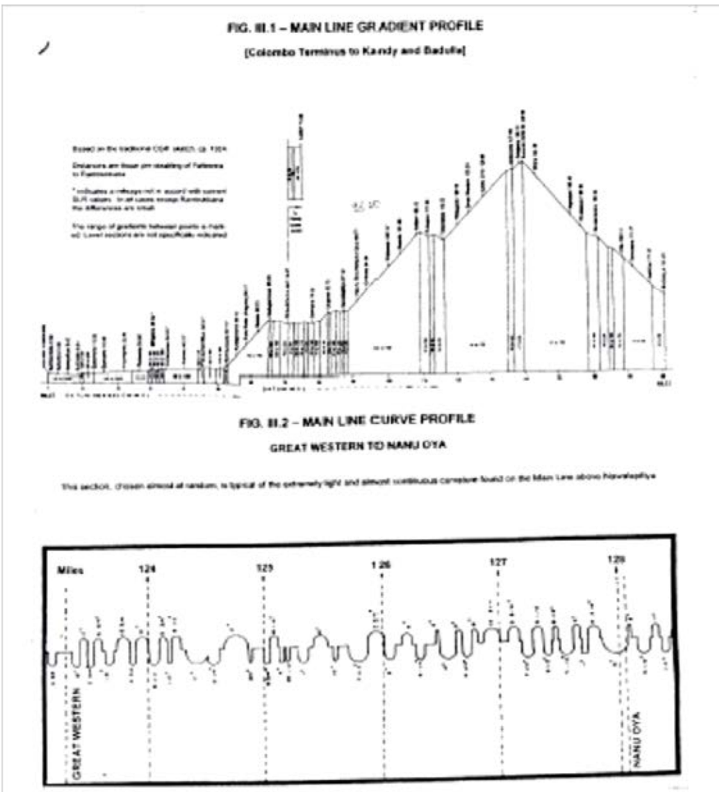
On Hill-Railways the **LIGHT–WEIGHT RAIL CARS** are fast climbing. The articulated ART Rail Car build from **STADLER**, Switzerland, with a two-axle middle traction module or power-container with two 500 hps power-packs (**Pict. 5 to 9; Pict. Gallery**) climbs in North Italy on an alpine railway line (Vinschgau-Railway) over tight curves the 1 in 35 Standard Gauge Inclines with up to 75 kmph; see **Pict. 5**. The long welded rails are fixed on **Steel-Sleepers** of Y-shape from ***THYSSENKRUPP***, which provide excellent curve geometry stability. **Y-Steel-**

Sleepers welded from double T-steel profiles, are used nowadays in Europe by several Mountain-Railways with tight curvatures; see **Pict. 13; 25a/b**. They can do with a thinner ballast cushion and do not need ballast-shouldering. They provide excellent lateral resistance of curvatures. That is, why trains can negotiate curvatures on Y-steel-sleepers faster than on tracks with concrete sleepers.

On the Sri Lankan broad-gauge incline sections with a ruling gradient of up to 1 in 44, which consist mostly of curvatures with a tightness of up to 18 Degree, which is unique for broad-gauge around the globe, the maximum train-speed is 35 kmph.

With **LIGHT–WEIGHT RAIL CARS** and rails clamped on **Y-Steel-Sleepers** resting on a clean and well drained ballast cushion it would be possible run up and down the Balana-Incline between Rambukkana and Kadugannawa with 65 kmph. This would increase the route capacity of the bottleneck to Kandy.

The ailing Up-Country Broad Gauge Line consists mostly of tight Curves with weak and badly drained rail-tracks**; Pict. 12, 14, 15; Pict. Gallery**. On several sections new Steel-Sleepers from India had been laid against all well known technical rules and specifications on wet mud with nearly no ballast. The weak track demands track friendly **LIGHT–WEIGHT RAIL CARS:**



Pict. 12: Main- and Upcountry-Gradient and Curve Profiles (Great Western to Nanu Oya)

LIGHT–WEIGHT RAIL CARS accelerate faster than conventional heavy Power-Sets or DMUs (Diesel Multiple Unites) and have a shorter braking-distance. They can negotiate tight curvatures faster with less strain to the track.

The new Chinese build push-pull **POWER-SET** S12 or DMU (Diesel-Multiple Unite) of **conventional heavy Rolling Stock design** with one 70 tonnes 1000 hps power coach in the front and one in the rear and 8 coaches in-between, Class S12, has a total weight of 480 tonnes; see Pict. No. 16. Much energy is needed to bring the set from sea level up to the Pattipola Summit at 1898 metre (the highest 5`6``- Broad Gauge Main-Line in the world). On the way down to Badulla the gained Potential Energy is transformed into Kinetic Energy and than dissipated as heat by the Dynamic Retarder Brake System.

Chinese conventional build S12 Power-Set with front and rear Power Coaches

With Stadler **LIGHT-WEIGHT Technology and with only one 70 tonnes and 1800 hps traction-van arranged in the middle of a light weight trailer set** the total train weight could be reduced by 210 tonnes; see 1 in 87 scale model for a **LIGHT WEIGHT LANKA ECONO RAIL CAR**, designed by Dr. F. Wingler on basis of the **STADLER** Middle Traction Module Concept, **Pict. 1; Pict. Gallery.**

LIGHT–WEIGHT RAIL CARS are a technical solutions for less fuel consumption and less wear and tear of the already ailing Sri Lankan rail tracks for longevity and lower overall Life-Cycle-Costs.

The initial idea of Dr. L. Perera for the **LANKA ECONO RAIL PROJECT** was, to take the under frames of old coaches, to provide them with new body-shells based on Bus-technology and to install on each trailer under-floor one 150 hps pack with a hydro mechanical transmission to the bogie-axles. The **power-packs should be distributed** over the train set under each coach. They have to be synchronised in driving as well dynamic-retardation brake mode. With only 150 hps per coach the vehicle would be underpowered.

The **under-floor arrangement** is not advisable under Sri Lankan Track and Maintenance-Conditions. By the **Power-Distribution Concept** the synchronisation of propulsion and retardation will become under Sri Lankan conditions Herculean tasks and will make the train set vulnerable to technical faults. The riding comfort of the old coach bogies, especially on the warped up-country tracks, is not any more up to modern technology.

For a fast running up-country service between 5 and 10 hps per ton train weight is desirable. Most **LIGHT–WEIGHT RAIL CARS** in Europe are installed with over 10 hps per ton train weight.

The concept of Dr. F. Wingler with “***TWO POWER-PACKS IN ONE VAN”*** instead of ***“ONE HEAVY DIESEL IN ONE POWER COACH, EACH AT FRONT AND REAR,”*** is based on the Swiss **STADLER** concept with the arrangement of the power coach as a **traction-van in the middle** of the train set and with trailer-dummies in the rear and front for the Driver’s Cabin; see **Pict. 8, 17, 18a/b; Pict. Gallery**. The Power-Packs are deployed on each wall-sides of the traction-van. In a Broad-Gauge **Traction-Van or Power-Module** there will be enough room for a 1 metre gangway or walk-through for the commuters; see **Pict. 7, 11; Pict. Gallery**. Both power-packs can be serviced from outside. In a joint venture the traction and auxiliary unites have to be build by Stadler and the Trailers can be assembled in Sri Lanka by Micro-Cars.

For better adhesion between rail and wheel taking into account the badly aligned Sri Lankan tracks the 4-axle B0`B0` **“TRACTION-VAN/POWER-MODULE”** version, based on a 2 ½ feet narrow Gauge Rail-Car build for Greece (see **Pict. 17, 24; Pict. Gallery**) is chosen. All the auxiliary equipments, light generator, brake systems, compressed air-system, batteries ect. are concentrated in one housing; see **Pict. 18a**:

Pict. 18**a**: **1 in** 87 **s**cale Model of **B0`B0`** *“TRACTION-VAN/POWER-MODULE”* for *LANKA ECONO RAIL* LIGHT WEIGHT RAIL CAR PROJECT; *“TWO IN ONE CONCEPT”.*

For long down-gradient runs a Dynamic Retarder Brake System is a prerequisite. Stadler developed a specific **DYNAMIC RATARDING BRAKE SYSTEM** for long downhill runs. The traction motors are shunted as dynamos feeding the alternator, which is shunted as a driving motor driving the Diesel-Engine; and the Diesel-Engine is set on retardation as an air compressor. The heat is dissipated through the conventional radiator system. An additional radiator for the dynamic brake system is not needed.

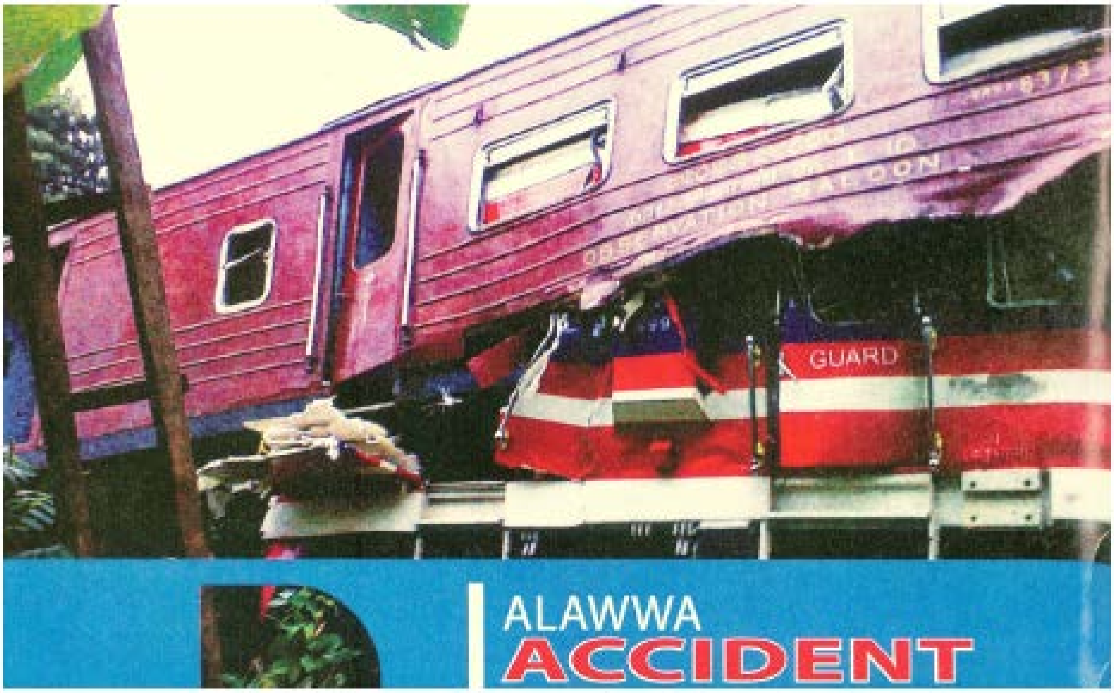
The Module-concept liberates from the trouble to synchronise the propulsion and retardation efforts of the individual power-packs distributed and dispatched over the train set in each car. With only **<u>one</u>** middle Traction-Van there will be no jerks in case of improper synchronisation. All the needed auxiliary equipments and installations can be concentrated in one Container.

The **MODULE-CONCEPT** has the advantage of less vulnerability to dust and salt spray with an easier access for maintenance, repair and power-pack exchange.

The Power-Module or Traction-Van can individually run as a ***"MINI-LOCO"***, which can be driven from small Driver's seats on both ends without incorporation in the train set.

The **LANCA ECONOMY RAIL CARS** must be crash-worthy and should fulfil the European Crash-Stability Norm EN1527. The **CRASHWORTHINESS** is defined by the **COMPRESSIVE LOAD** of at least 3.0 Mega Newton, the Front Part can withstand without structural collapse, and by the **ABSORPTION/DISSIPATION** of **KINETIC CRASH-ENERGY** of at least 1,5 Mega Joule without integrity-deformation of the Driver's cab survival zone. In other words, the Driver should have a chance to survive in a survival zone at a crash with a heavy vehicle at 80 kmph; see **Pict. 19 to 23; Pict. Gallery.**

At **ALAWWA** Driver and Assistant got killed in the crash-unworthy Indian build S11 front cabin made out of Glass-fibre-Polymer-Resin composite, which fully disintegrated at the impact, when colliding with only 38 kmph with the rear of the Kandy-Intercity. Driver and Assistant got crushed to death against the wall of the engine room by the intruding debris:

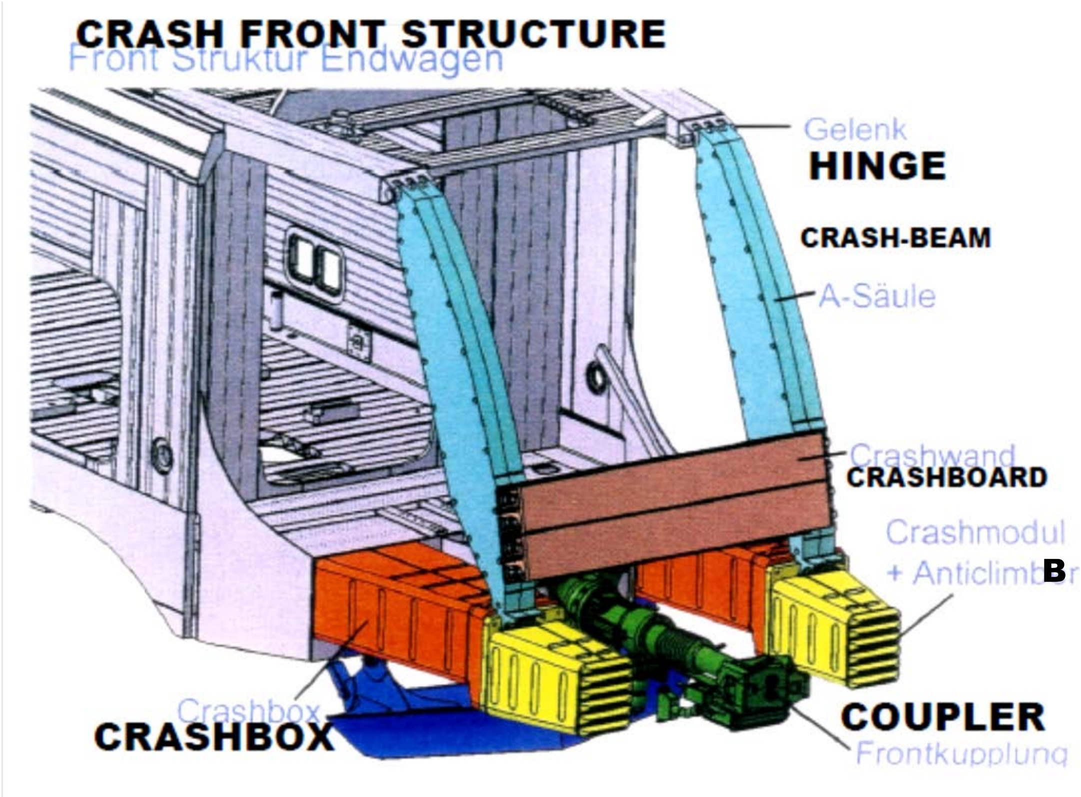


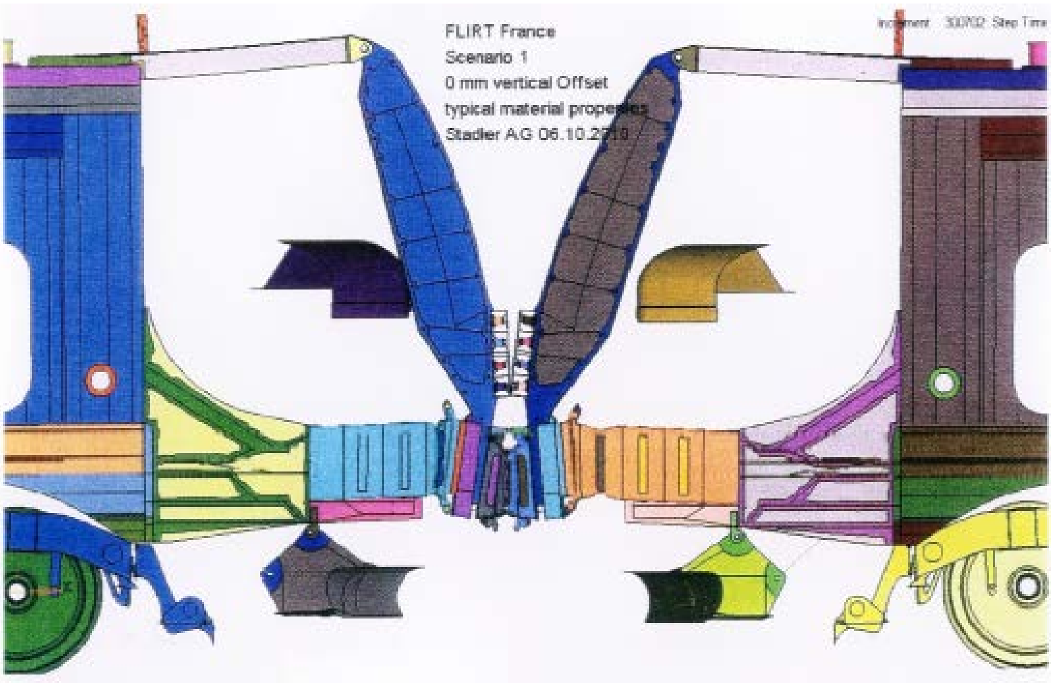
Pict. RAIL 2012, Edition 03, July 2012, Railway Engineers Association, Sri Lanka Railways, Colombo-10, Sri Lanka

The crashunworthy Polyester-Glasfibre Front Part of the Indian build S12 disintegrated at a rea-end C**ollision** at Alawwa**, 17.09.2011; Sri Lanka**

The crashunworthy Polyester-Glasfibre Front Part of the Indian build S12 disintegrated at a rea-end **Collision** at Pothuhe**ra, 30.04.2014; Sri Lanka**

The **Stadler-Crash-Concep**t (see **Pict. 19 to 23; Pict. Gallery**) works with two strong steel side beams connected with the roof by a hinge and connected over a **“Crash-Box”** at the bottom with the coach frame. The **“Crash-Box”** is functioning as an energy absorbing crumble zones. The Buffers and the Coupler are integrated in the Crash-Energy-Absorption scheme. The following picture sequence illustrates the Mechanism of Crash-Energy Absorption:





Energy Absorption by Deformation of “CRASH-BOX”

Crumbled “CRASH-BOX” after Crash-Test

The **CRASHWORTHINESS** is tested by Computer-Simulation as well physically on bending test-rigs and by field Crash-Tests of Elements. In USA, where the Norms demand higher stability and energy-absorption, real-life Crash-tests of Rail Vehicles are performed.

The salient crash-feature for our **Lanka Econo Rail** Design is a higher remote Driver’s Windscreen between two Crash-Side-Beams and a Crash-Board above the coupler and buffer zone behind the cladding. Buffer and Coupler are an integrated part of the Crash-Energy Absorption Scheme.; see **Pict. 23; Pict. Gallery.**

Lanka Econo Rail LIGHT–WEIGHT RAIL CARS are a feasible case for a Rapid Business Intercity-Service between Colombo and Kandy, for a Commuter Shuttle Service in the Triangle Kadugannawa-Kandy-Nawalapitiya via Peradeniya, for a Shuttle Service between Badulla and Bandarawela and for a **Rapid Transit System** on the alignment of the **Kelani Valley Line (KV-Line)** to serve the Suburban area up to Avissawella (with an elongation option up to Ratnapura) with intermodal Bus-Rail Services in-between.

The S8 and S12 Broad-Gauge Power-Sets can negotiate the sharp KV-Line curvatures with missing curve-transitions not faster than 35 kmph. The presently slow suburban train service can not compete with a road bus service. To straighten the alignment in order to reduce the curve-tightness from presently 18 to less than 6 Degree is not possible due to the dense populated and build area. There are plans to resettle the dwellers along the trace, but this will not work due to financial and political reasons. To build a second rail access to Hambantota over the KV-alignment via Embiliptitiya is a dream resting in cuckoos nest. Such a line wil be neither technical nor economical feasible.

It had been a big mistake to convert between 1991 and 1997 the **2 ½ feet Narrow Gauge (NG)** with its sharp curvatures to Broad-Gauge. The KV Line was running once beyond Ratnapura up to Opanake.

The Stadler 2 ½ feet OSE Narrow Gauge Rail-Car build for Greece reached 80 kmph on test runs in Germany on a rehabilitated Narrow Gauge track; see **Pict. 24**. In Switzerland, which has a vast meter-Gauge Network, the Rail-Car Trains run 120 kmph, and in South Africa on the 67 mm wider **"CAPE"** Gauge trains run up to 160 kmph.

An advisable option would have been to upgrade and modernise the NG up to **Ratnapura** or to convert the NG to Meter-Gauge. On Y-Steel Sleepers (see **Pict. 13, 25; Pict. Gallery) a** Meter-Gauge Rail-Car could negotiate the given tight curvatures with 60 to 80 kmph.

Y-Steel-Sleepers could be manufactured in Sri Lanka by Colombo Dockyard. The needed double-T Steel bars (see **Pict. 25b; Pict. Gallery**) could be imported. Since all KV-line trains are terminated at Fort, a brake in gauge would create no logistic trouble. But to challenge the KV-line conversion to Broad Gauge is regarded by upper echelons in the Railway Department as a sacrilege.

There had been aspirations to electrify lines in Sri Lanka. <u>The prerequisites for electric traction are not given in Sri Lanka.</u>

To run trains electric need a huge financial investment sum for new rolling stocks, infrastructure, reliably power supply. There must be land for the overhead electric supply line (catenary) posts. Telecommunication has to be shielded. There is a brake-even-point of traffic density, from which on the investments for electric traction will be economical. This traffic density is not reached in Sri Lanka.

For a reliable electric train service a network of power stations providing enough redundancy in the country is needed for an uninterrupted electricity supply around the clock and around the year. The electricity production in Sri Lanka is not reliable enough for an electrified train service.

Sri Lanka is short of financial resources to keep even the present Railway System in good running conditions. There is a lack of proper maintenance, services and repairs of track and rolling stocks. There are not enough workshops, running sheds, spares and skilled and well trained manpower and well paid engineers to keep the timetable and to run all trains on time. Brake-downs of trains on the lines are already on increase.

PICTURE GALLERY

LANKA ECONO RAIL

Pict. 1: 1 in 87 Scale Model of the ***"LANKA ECONO RAIL"*** Light Weight Rail-Car Concept with Middle Traction-Module and crashworthy Driver`s Cabins

Experts helps Micro Cars to Develop Trains

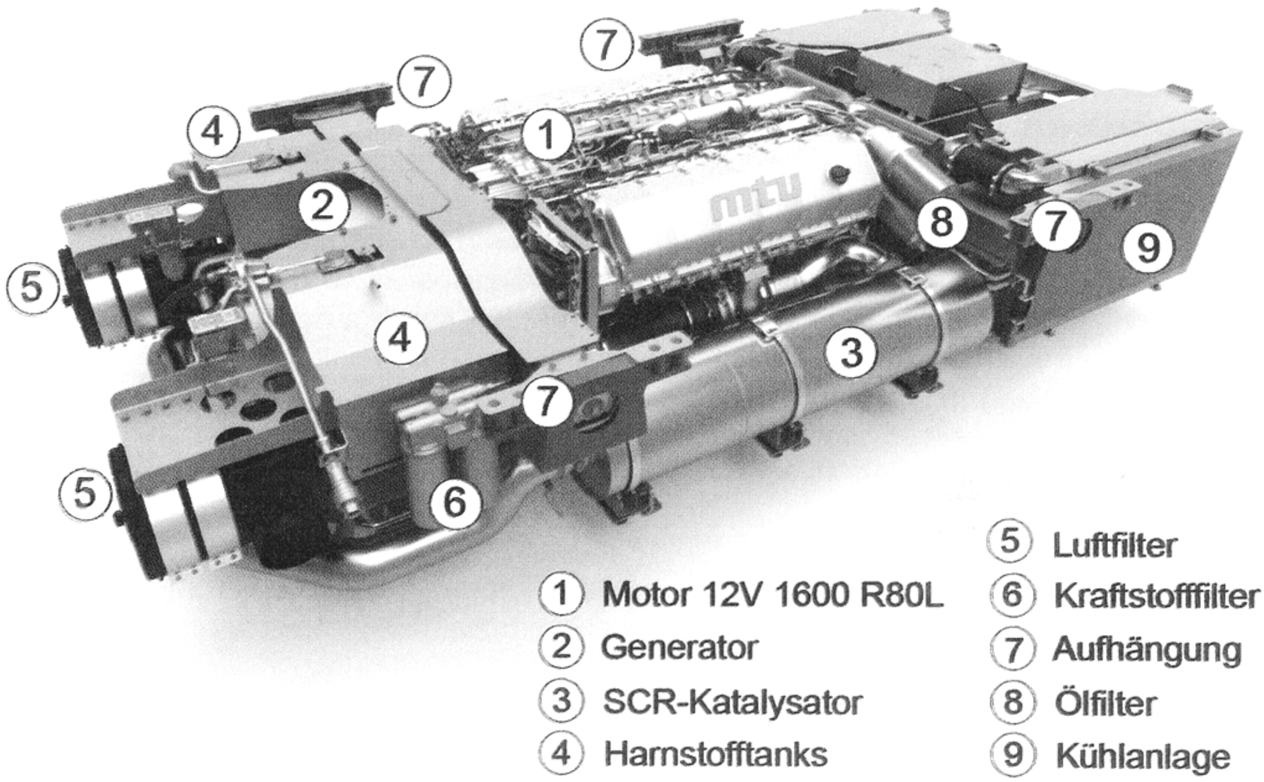
Tuesday 3rd February 2011,

Dr. Frank Wingler a well known German Rail expert, recognizing the efforts made by Micro Cars Limited to develop mass transport system in Sri Lanka using light rail concept to design and manufacture "Power Distributed Light Rail Cars" named Lanka Econo Rail.

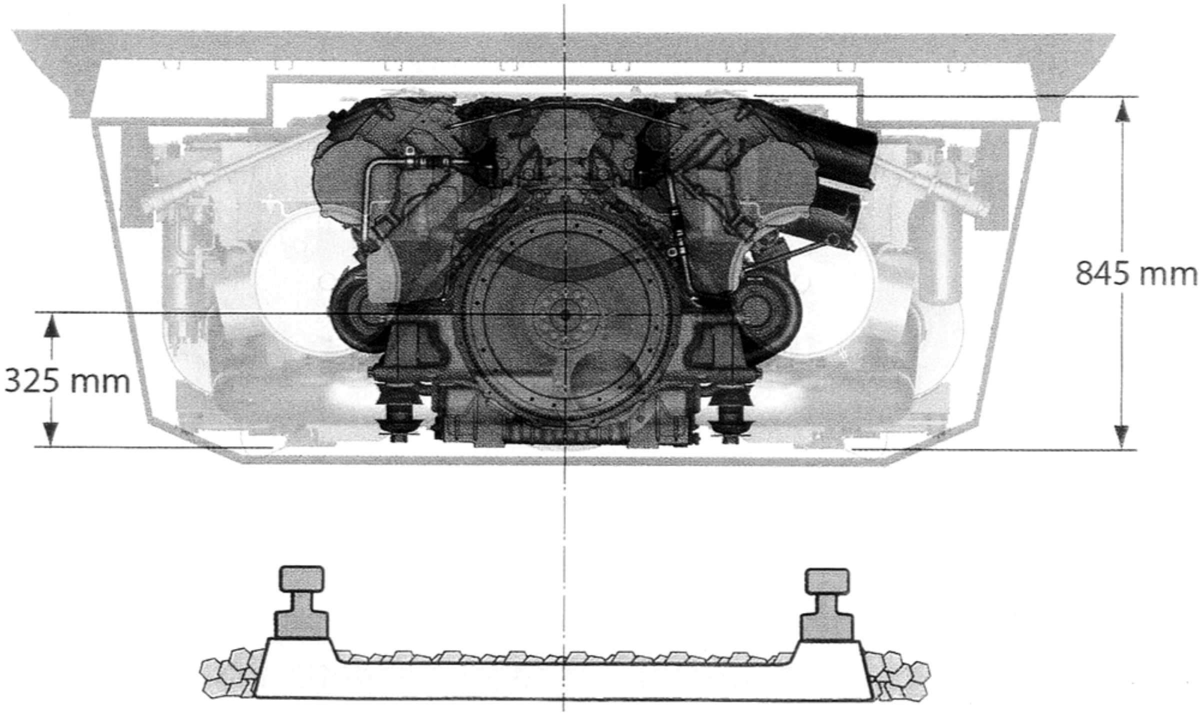
Dr. Wingler presented a model of a Power Distributed Light Rail car to Dr. Lawrence Perera as a concept model of Lanka Econo Rail.

Dr. Frank Wingler has long battled the railway authorities in his voluntary efforts to improve the service. Despite the high investment and the recent overseas assisted rehabilitation programmes, there is not a single mile of stable, long-lasting and nearly maintenance-free and hump-free rail track in Sri Lanka, until this year, that can compete with thousands of miles of rehabilitated rail tracks in other developing countries like in India, China, Mongolia, Korea, Morocco, West Africa, South Africa, New Zealand etc., he says.

Pict. 2: 225 kmph ALSTOM Diesel-electric Rail-Car with under-floor distributed and synchronized Power-Packs; Virgin-Train, UK

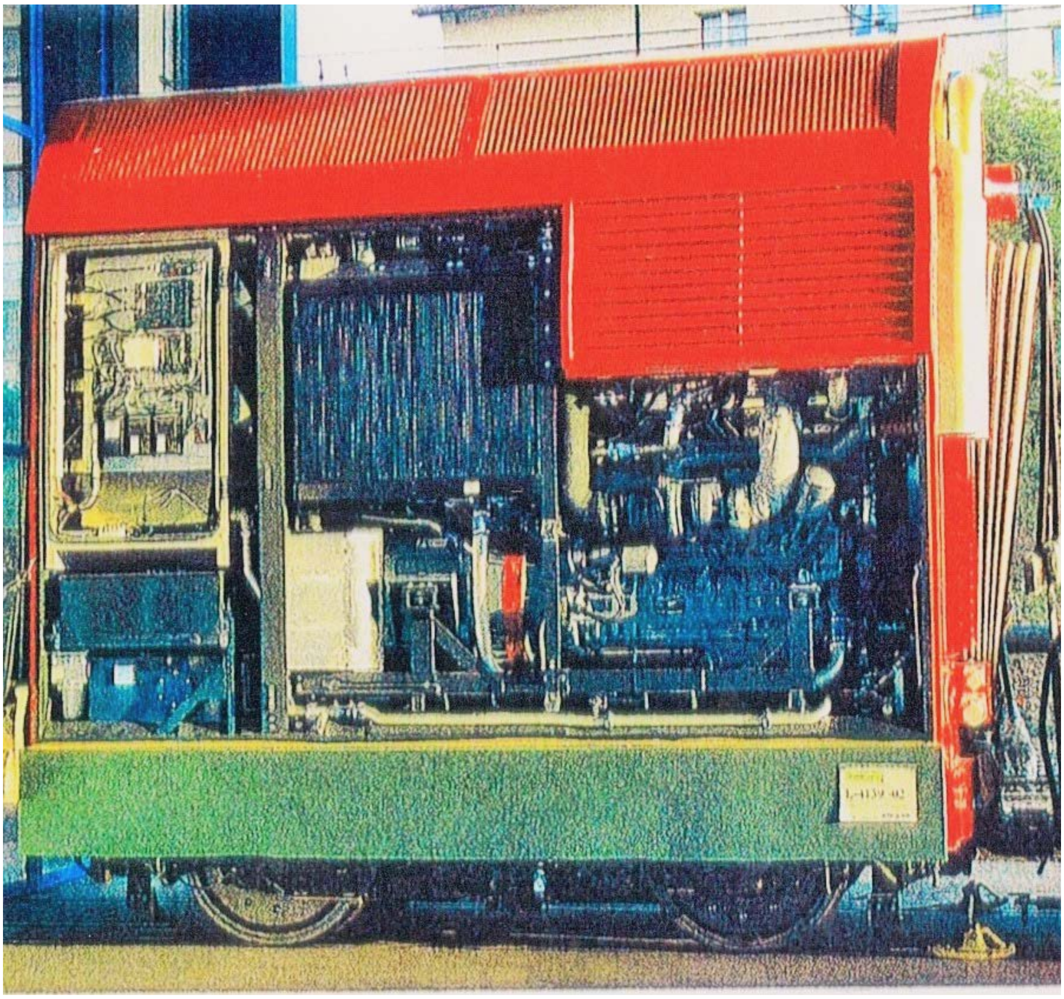


Pict. 3: MTU 900 hp *"POWER PACK"* with 12 Cylinder V-Engine, Generator/Alternator, Cooling-System and Exhaustion Cleaner (with Urea)



Pict. 4: Circumference of Power-Pack Under-floor Arrangement

Pict. 5: Articulated Stadler **B0`B0`** Light Weight Rail Car with **B0** Middle Traction**-** Module on Mountain Railway with 1 in 35 ruling Gradient, Vinschgau, North Italy

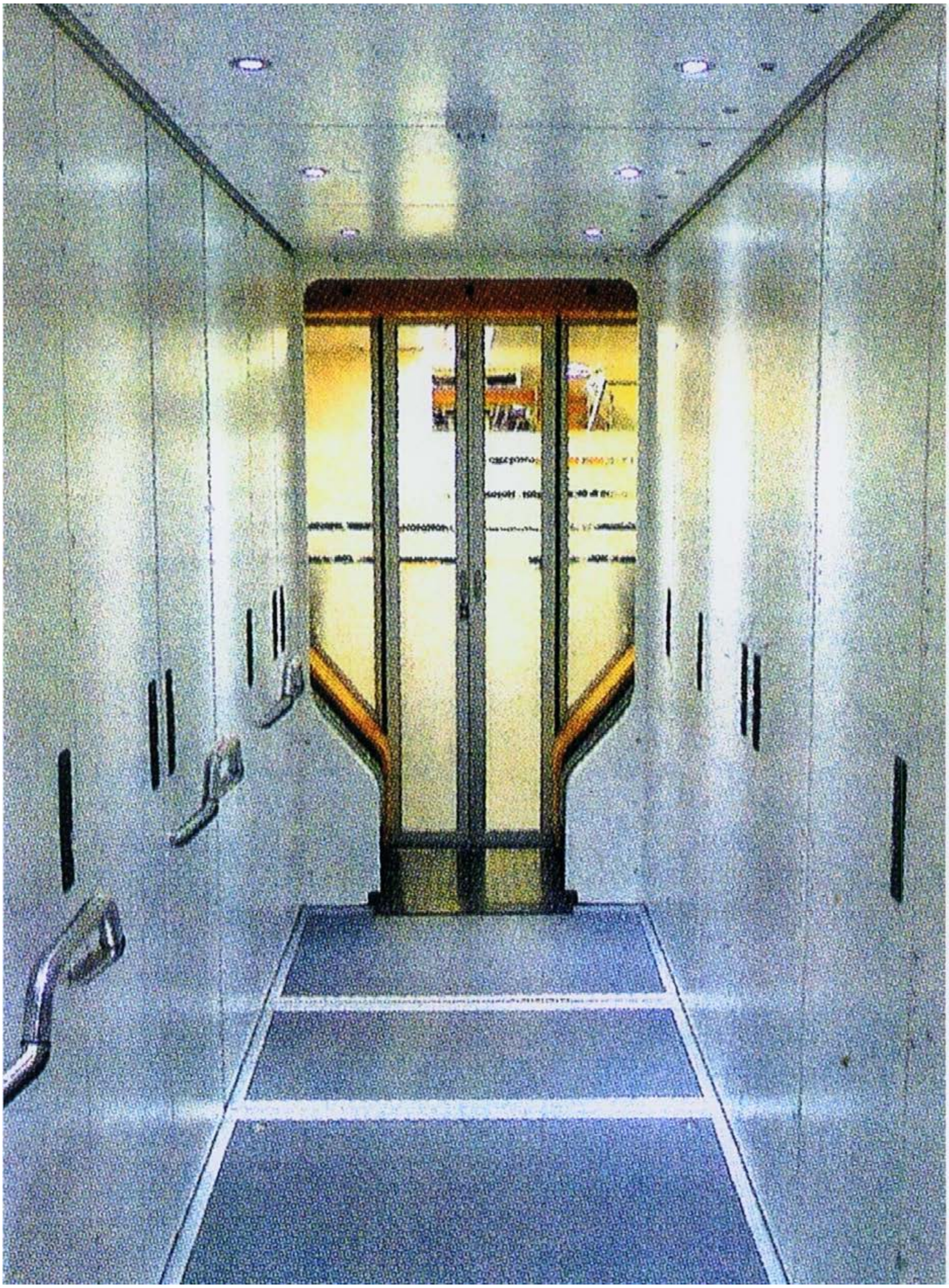


Pict. 6: B0`**B0**`Traction-Module**;** with two Power-Packs **(*"TWO-IN-ONE"* Concept) o**f Stadler articulated light Weight Rail Car

Pict. 7: Passenger Gangway through Traction-Module

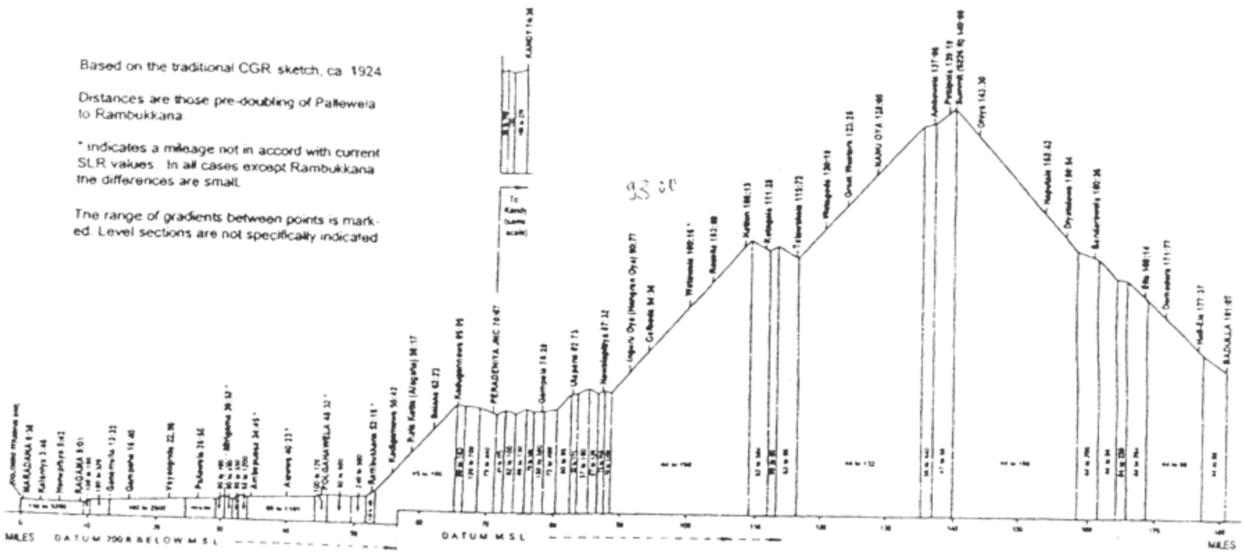
Pict. 8: B0 Traction-Module of articulated Stadler ART Rail Car

Pict. 9: Assembling of a 4 Axle B0`B0` Traction-Module for a**n a** Russian Broad Gauge articulated Stadler ART Rail Car **for** Lithuania



Pict. 11: Passenger Gangway inside B0`B0` Traction-Module of articulated ART Russian Broad Gauge Rail Car

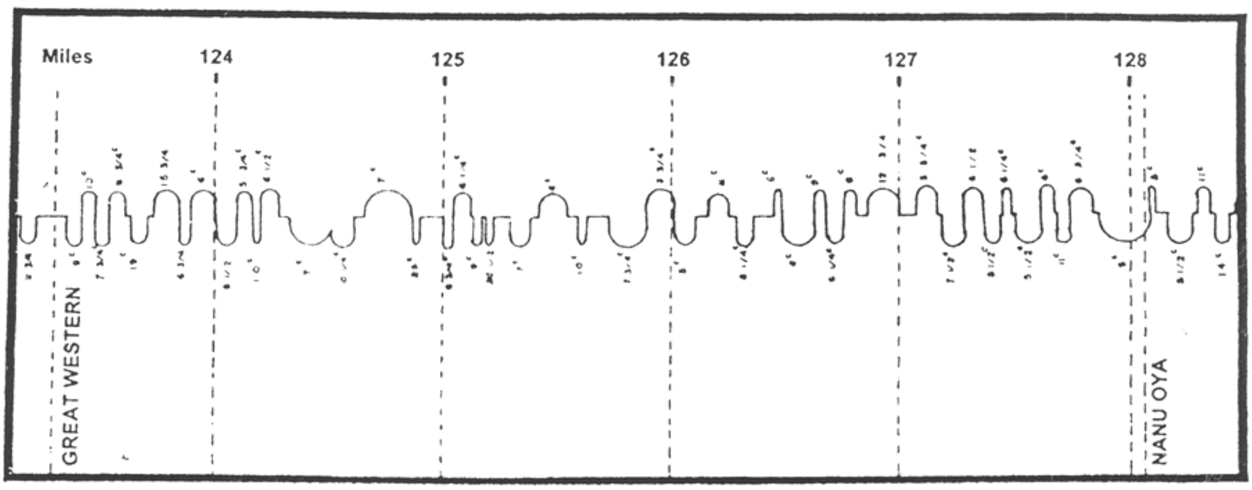
Main Line Gradient Profile from Colombo to Badulla



MAIN LINE CURVE PROFILE

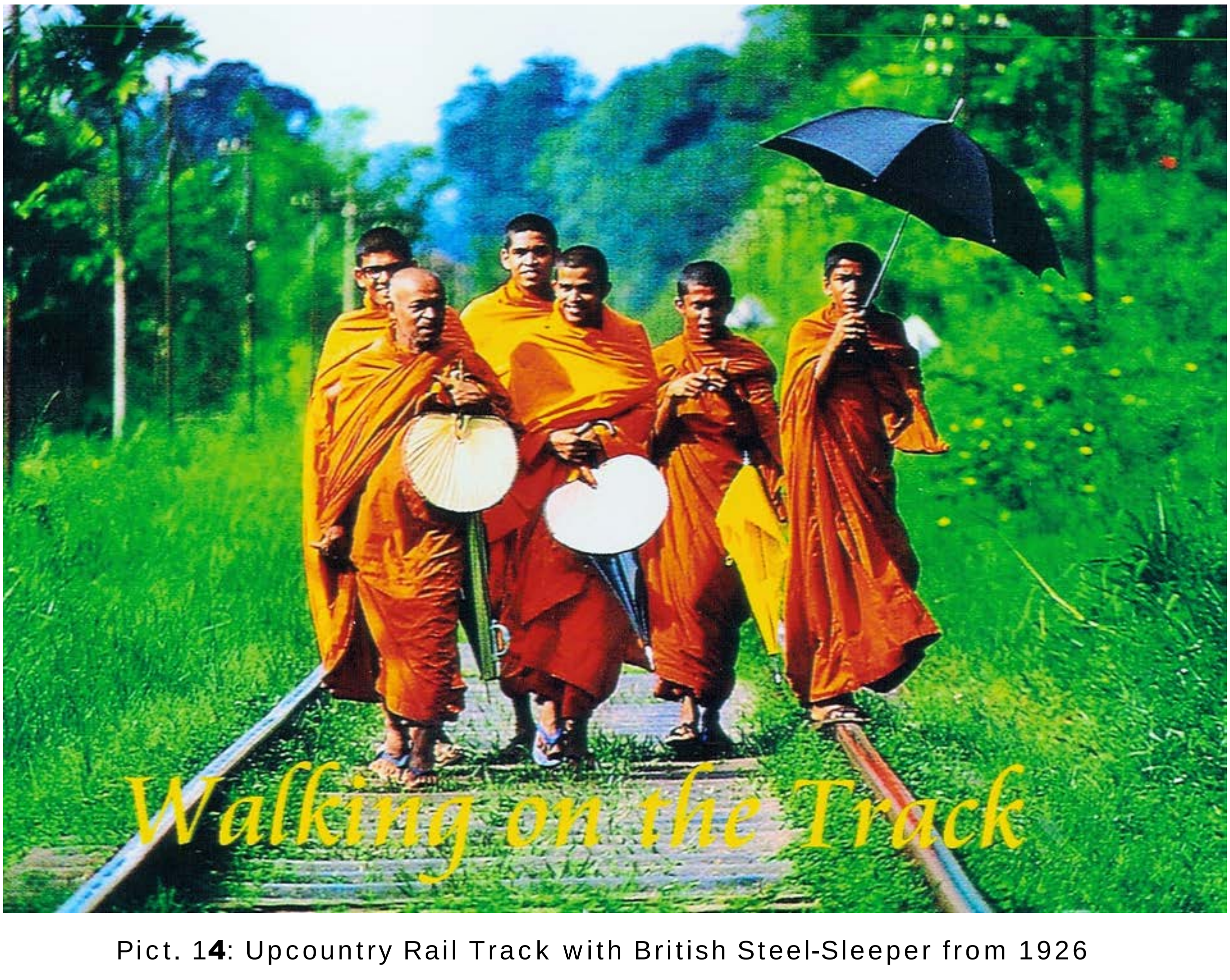
GREAT WESTERN TO NANU OYA

This section, chosen almost at random, is typical of the extremely tight and almost continuous curvature found on the Main Line above Nawalapitiya.

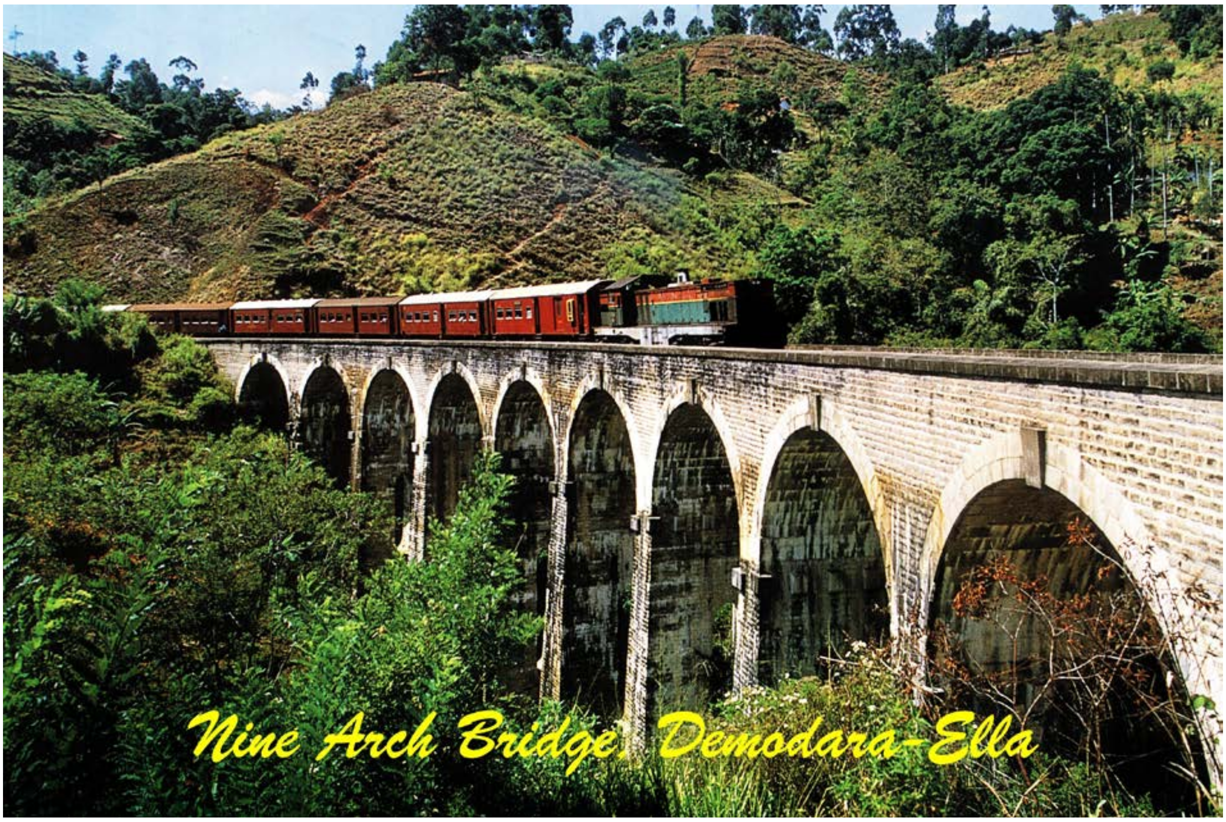


Pict. 12: Above: Diagram for Line Gradient Profile from Colombo to Badulla via Pattipola; below: Diagram of Curvature Profile from Great Western to Nanu Oya; from David Hyatt *RAILWAY OF SRI LANKA*, ISBN 0-9537304-0-9

Pict. 13: ThyssenKrupp Y-Steel Sleepers on Mountain Railway with tight Curvatures; Alpine Vinschgau Railway, North Italy



Pict. 14: Upcountry Rail Track with British Steel-Sleeper from 1926



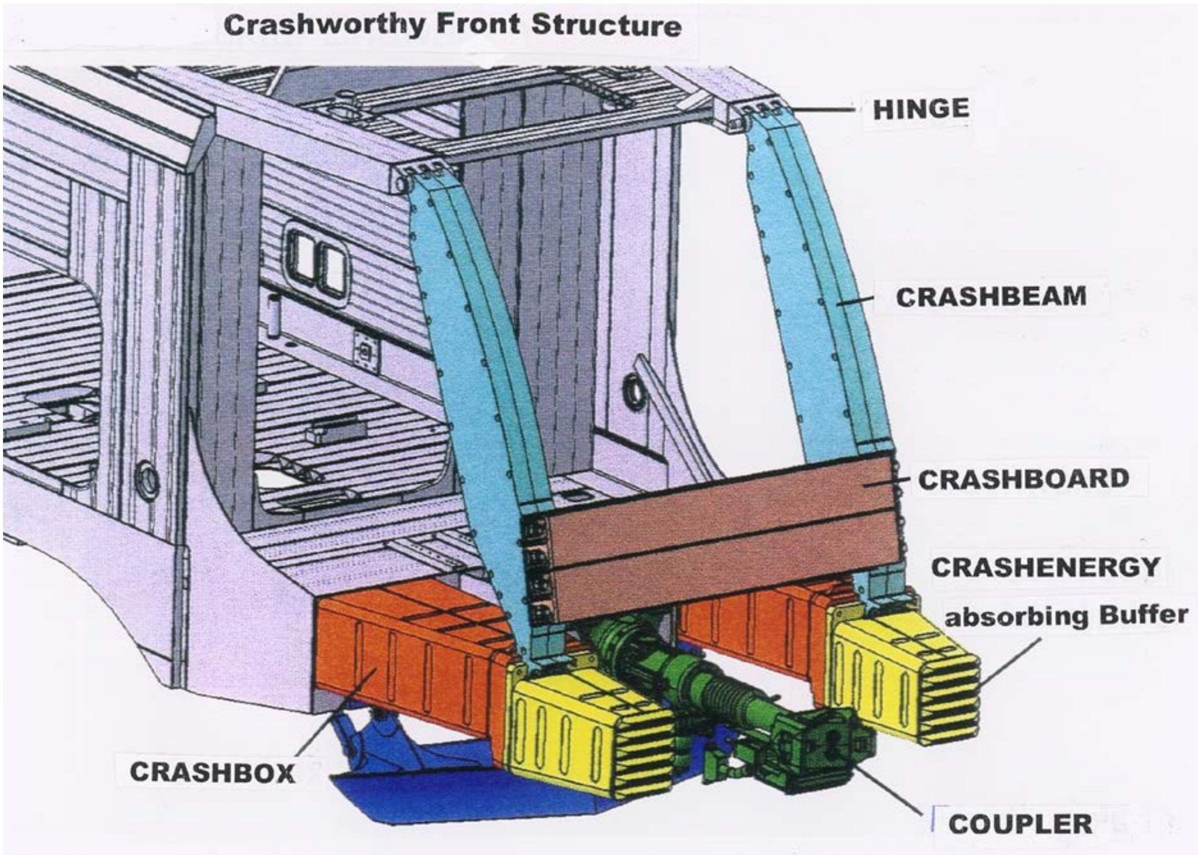
Pict. 15: Nine Arch Bridge; Upcountry Line, Sri Lanka

Pict. 16: China build Class S 12 Power-Set Train with two **heavy conventional** Pull-Push Power-Cars; 2 **x *"ONE-IN-ONE"* Concept**

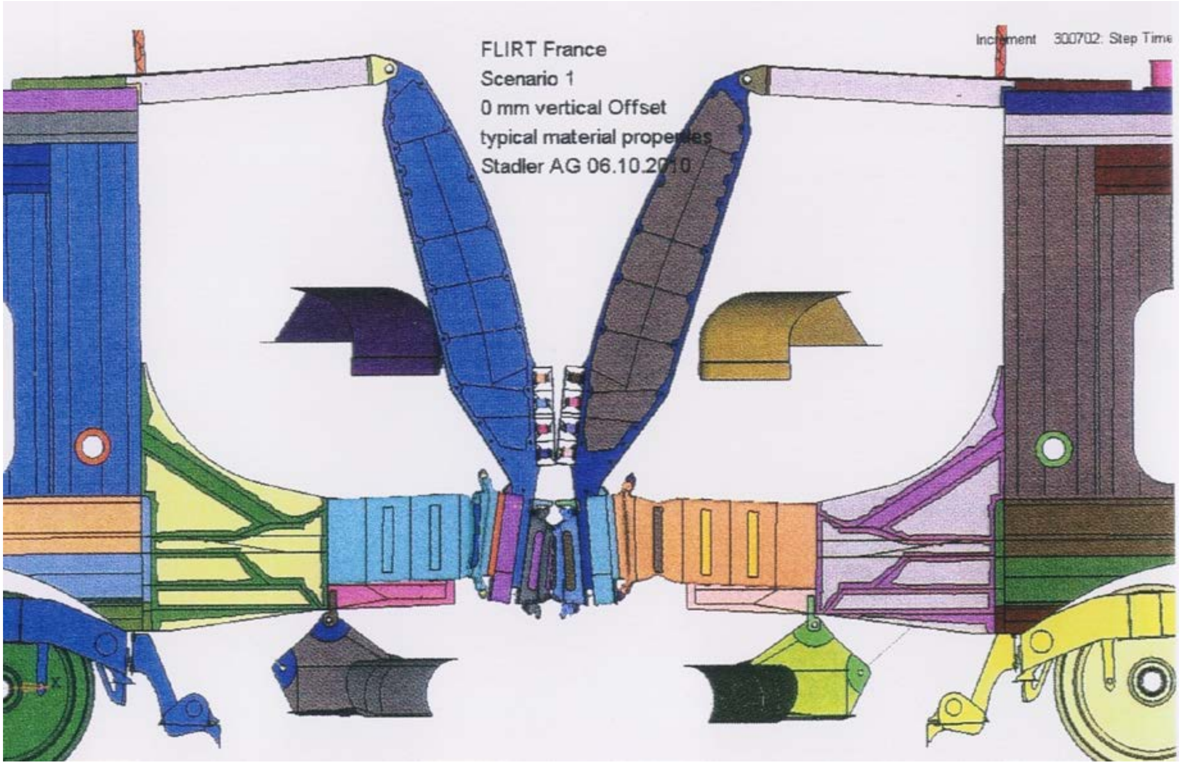
Pict. 17: Stadler build Narrow Gauge Light Weight Rail Car with 900 hp Diesel-electric Traction in a Middle B0`B0` Traction-Van/Module, Type BDmh27+4A/12, Diakofto Railway, Greece

Pict. 18**a: 1** in 87 Scale Design Study of a **B0`B0`** Middle Traction-Van/Module with two **900 hp Power-Packs (*"TWO-IN-ONE"* Concept) for the *LANKA ECONO RAIL PROJECT***

Pict. 18**b**: 1 in 87 Model of Lanka Econo Rail Car with crashworthy Driver`s Cabin

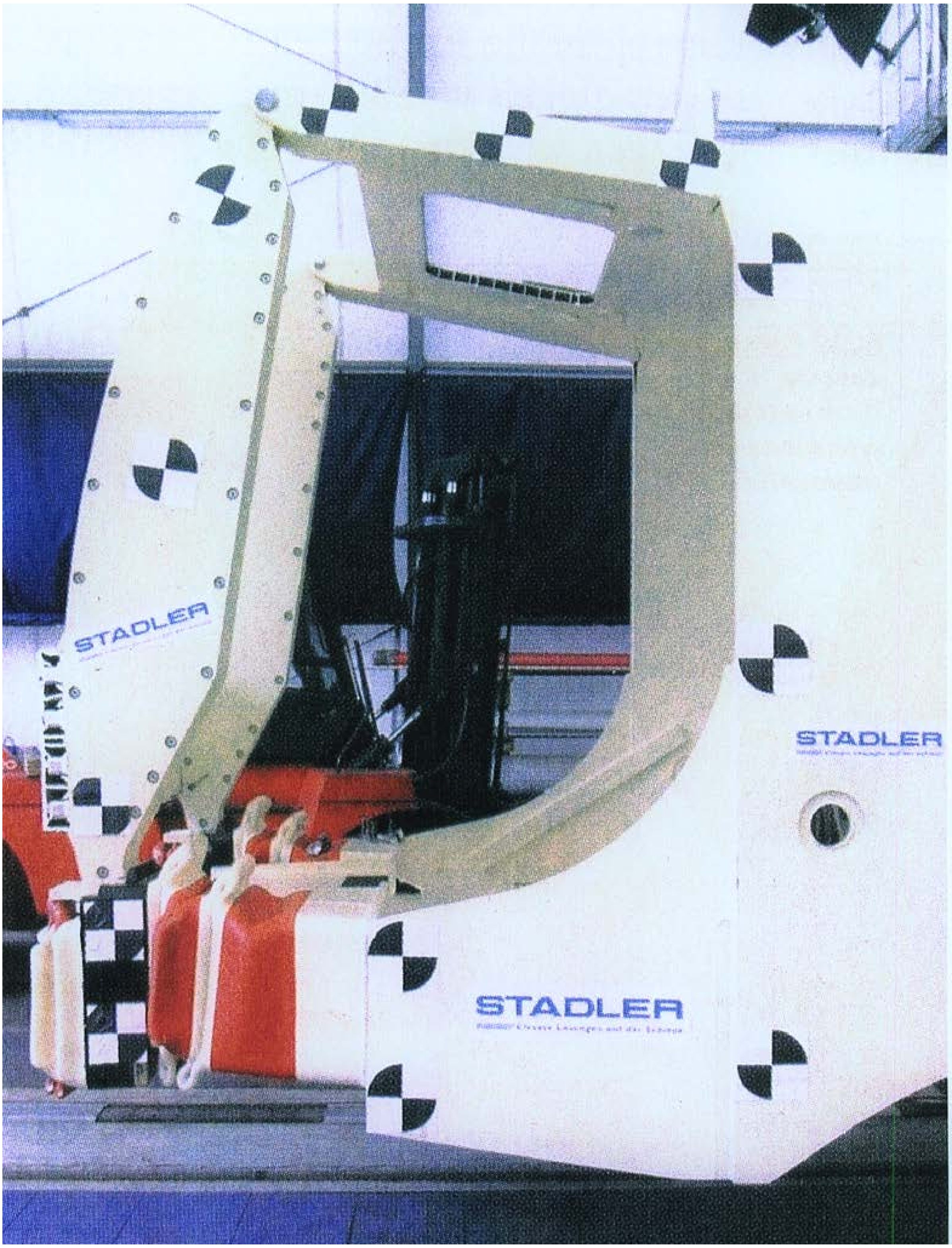


Pict. 19: Energy absorbing Crash Elements of Stadler Rail Car

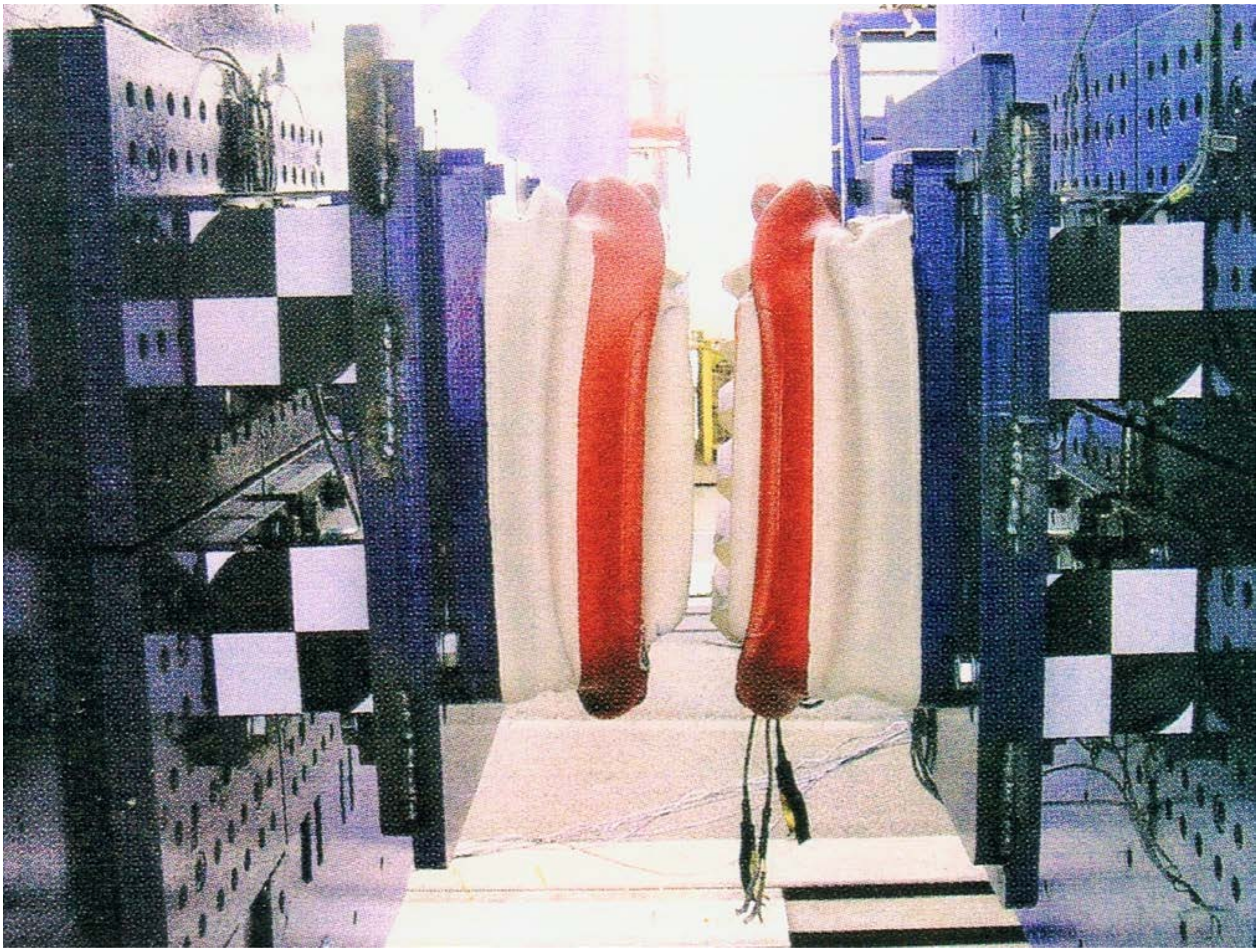


Pict. 20: Illustration of Crash Energy Absorbtion

Pict. 21: Crash Test Arrangement



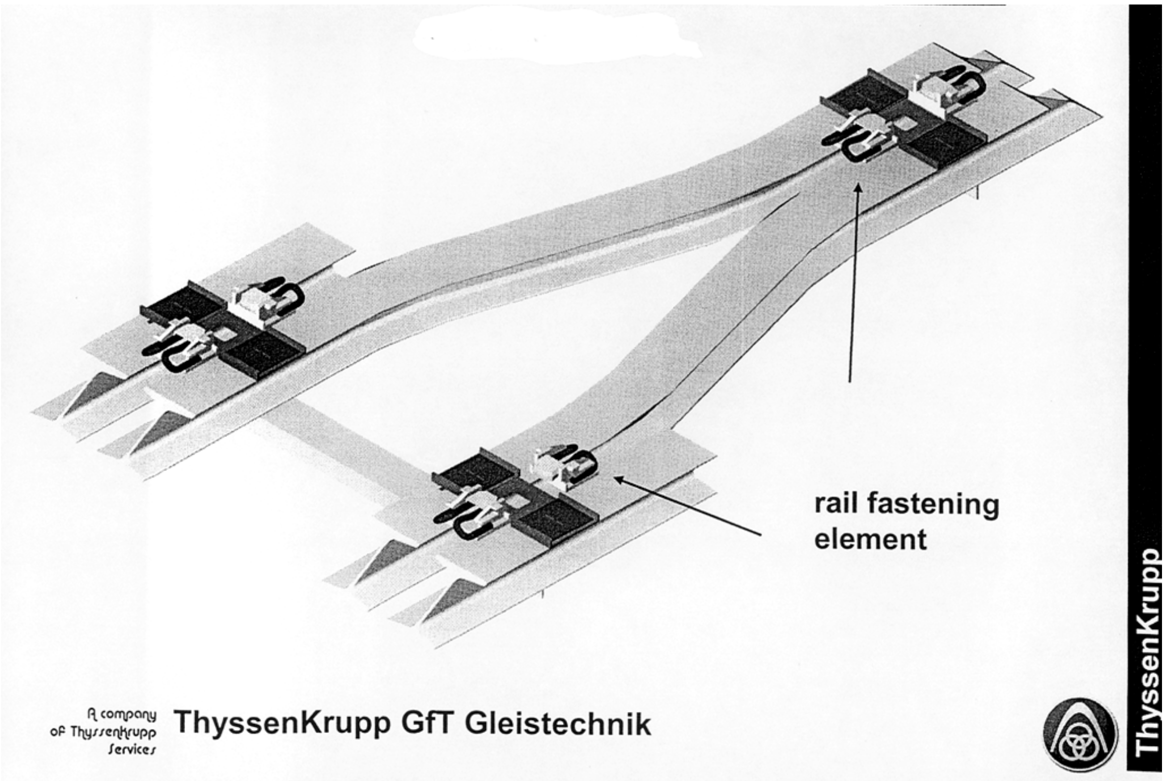
Pict. 22: Deformation of Crash Box after Crash Test



Pict. 23: Deformation of Crash Box after Crash Test

Pict. 24: Test Run of Stadler 2 ½ ft Narrow Gauge Rail Car with Middle Traction-Van in Germany, 2007; max. Speed: 80 kmph

Pict. 25a: ThyssenKrupp Y Steel Sleepers



Pict. 25b: Layout of ThyssenKrupp Y Steel Sleeper with Pandrol Fast-Clips