WITHER CURVE CHECK-RAILS
OPTIMAL FRICTION-MANAGEMENT
for low TRAIN CURVE-RESISTANCE and low RAIL/WHEEL-WEAR

Check-Rails on Curves create a lot of pain for little or no benefit!

Advices:

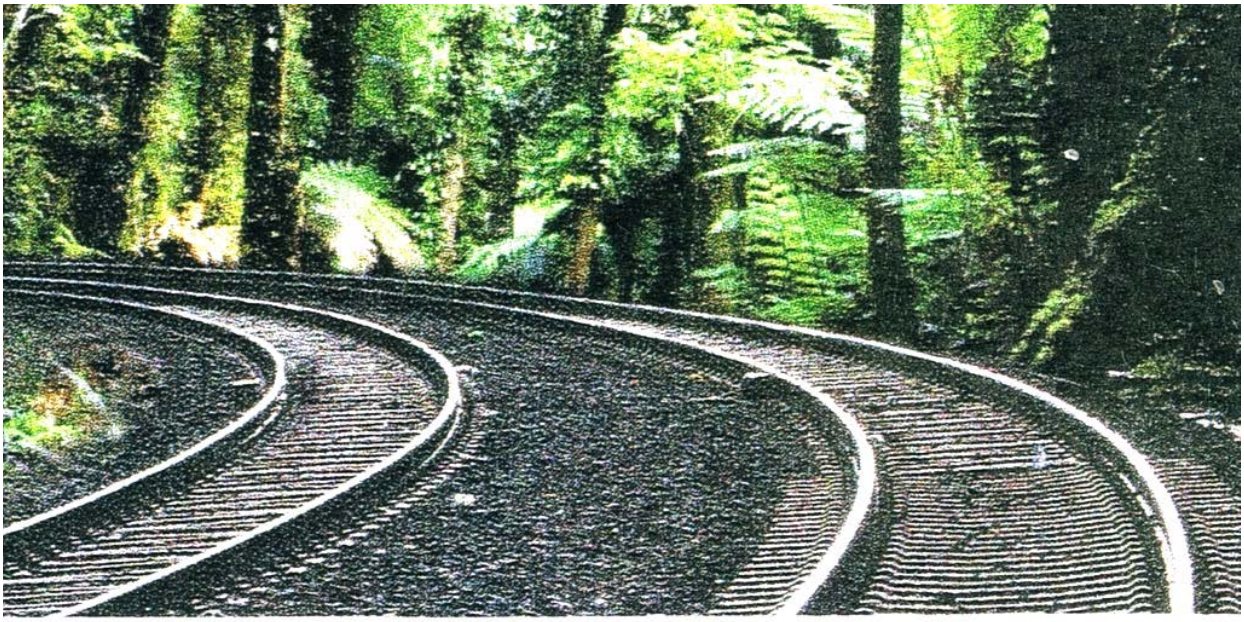
<> Keep the track geometry parameters ↔ super-elevation, rail-cant, gauge-widening, rail-alignment, fish-plate joints ↔ in perfect condition within a narrow tolerance, gym the curve rails properly, so that there will be no kinks; best use at least 20 m or longer rail panels,

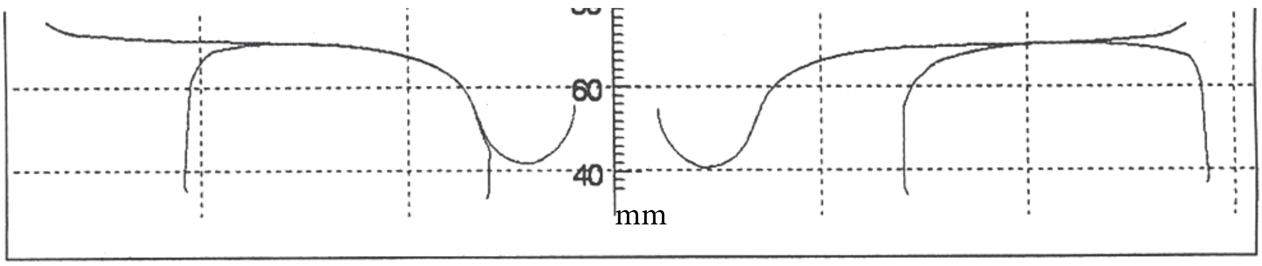
<> target grind the rail-profile for low friction,

<> lubricate well the high-rail running corner (rail gauge-face),

<> keep the wheel-profiles and wheel-treats properly profiled within narrow tolerance,

<> bring the rail-grid on a proper ballast cushion and on a well bearing formation.





Optimal Curve-Rail and Wheel-Profiles for high (left) and low (right) **R**ail **by Target Grinding**; see Dr. W. Schoech, SPENO, Switzerland in RAILWAY GAZETTE, Jan. 2012, p.47; LBF Foster Friction Management, USA

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WITHER CURVE CHECK-RAILS IN INDIA AND SRI LANKA

Curve Check-Rails create a lot of pain for little or no benefits!

Check-Rails should only be provided on Curves if a RISK OF DERAILMENT has to be lowered!

The better solution than Check-Rails on Curves is an APPROPIATED FRICTION-MANAGEMENT!

The author had been asked by an SRI LANKAN IPW, what to do to reduce **WEAR** and **TEAR** and hence **TRAIN-RESISTANCE**, when a train negotiates a curve.

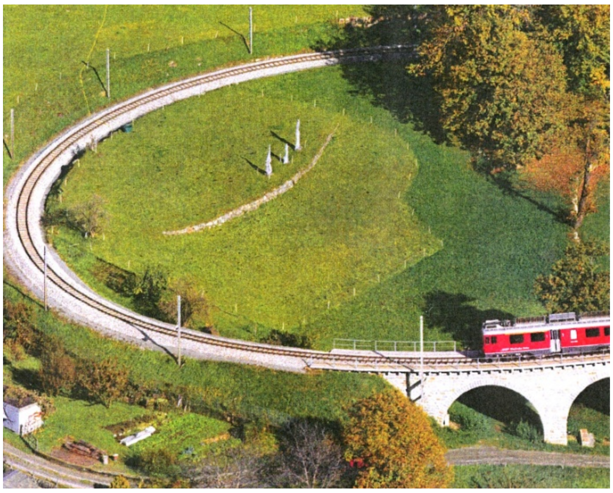
CURVE CHECK-RAILS are in Sri Lanka like a ***"HOLY COW",*** and to challenge the benefits might be regarded as a ***"SACRILEGE"***.

CURVE CHECK-RAILS are a relic from England, the cradle of Railways. European Railways do not use Check-Rails in order to guide the wheels round the curves. And they know why!

Curve Check-Rail with Pandrol Bracket-Fastening and e-Clip Rail-Fastening in South-Africa

One of the most spectacular curves **WITHOUT CURVE CHECK-RAILS** are the Swiss meter gauge curve with 45 m or 39 Degree tightness on trough steel-sleepers with rigid bolt fastening on the famous alpine ***"BERNINA-PASS RAILWAY"*** at **ALP GRÜM** and the 70 m curve at **BRUSIO**:

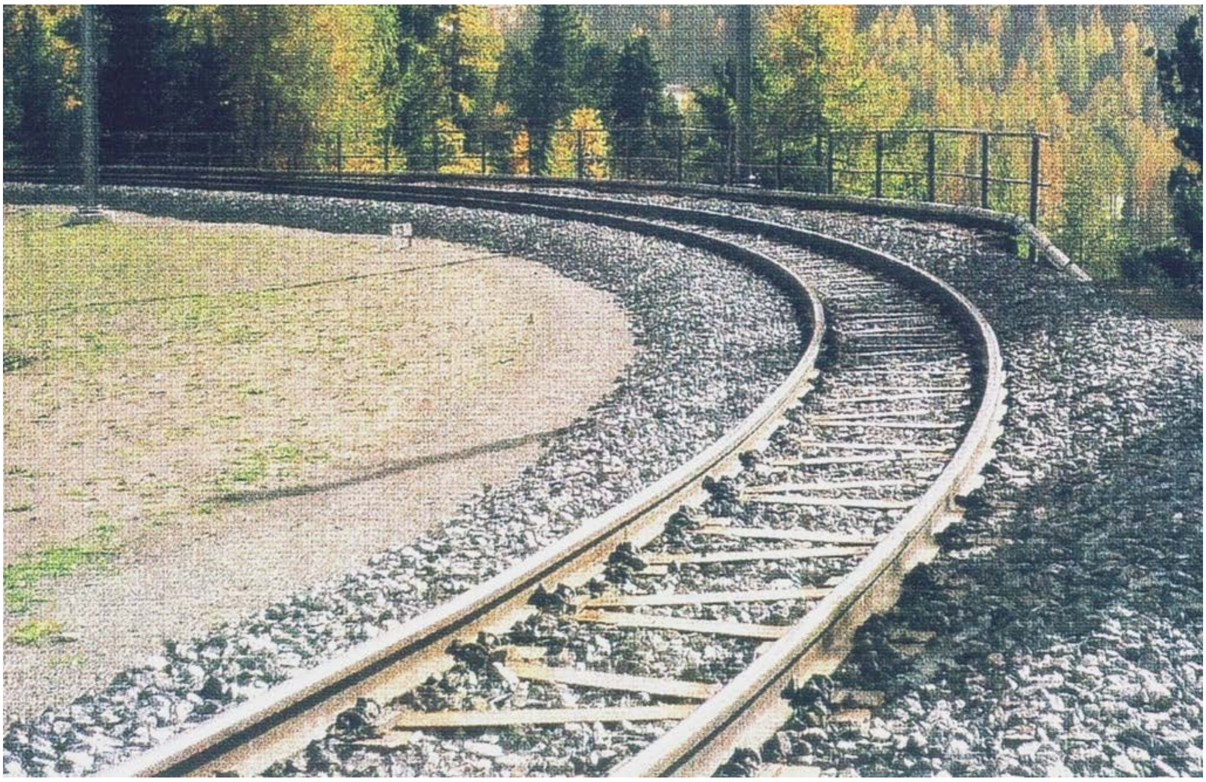
Alp Grüm



Alp Grüm **Brusio**

39 Degree **(left) and 25 Degree (right)** Meter Gauge Curves on BERNINA RAILWAY; Switzerland; without Check-Rails

The next picture delineates a 50 m radius meter gauge Rail Track with **LONG WELDED RAILS** on the Bernina Railway without a Curve Check-Rail on **ThyssenKrupp Y-Steel Sleepers**:



A 50 m Radius Continuous welded Curve of the Meter Gauge Bernina Railway on **Y-**Steel-Sleepers

Y Steel-Sleepers are the most solid and sturdy solution for curves without check-rails for mountain railways, especially on narrow and troublesome formations. In Sri Lanka a track on Y Steel-Sleepers without curve check-rails would be the optimal solution for the ailing ***BALANA INCLINE*** from Rambukkana to Kadugannawa.

The better solution **instead of Curve Check-Rails is** to run a train in a curve with low friction, **TRAIN RESISTANCE** and with a minimum wear and tear of rails and wheels by an appropriate **FRICTION MANAGEMENT:**

<> Keep the track geometry parameters - transitions, body or circular curve parameters, super elevation, rail cant, gauge widening, rail alignment, fish plate joints - in perfect condition within a narrow tolerance, gym the curve rails properly, so that there will be no kinks; best use at least 20 m or longer rail panels,

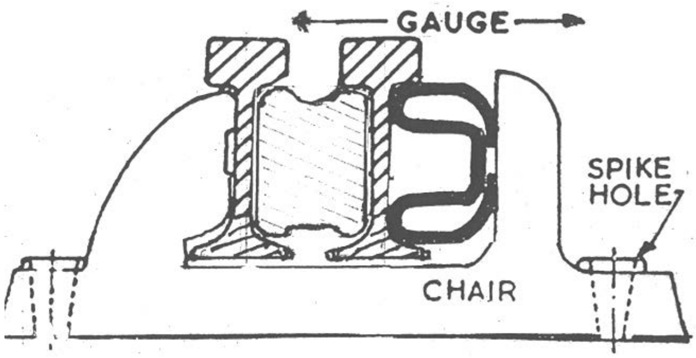
<> target grind the rail-profiles for low friction,

<> lubricate well the high rail running corner (rail gauge- face),

<> keep the wheel profiles by rail grinding and wheel treats by lace cutting properly profiled within narrow tolerance,

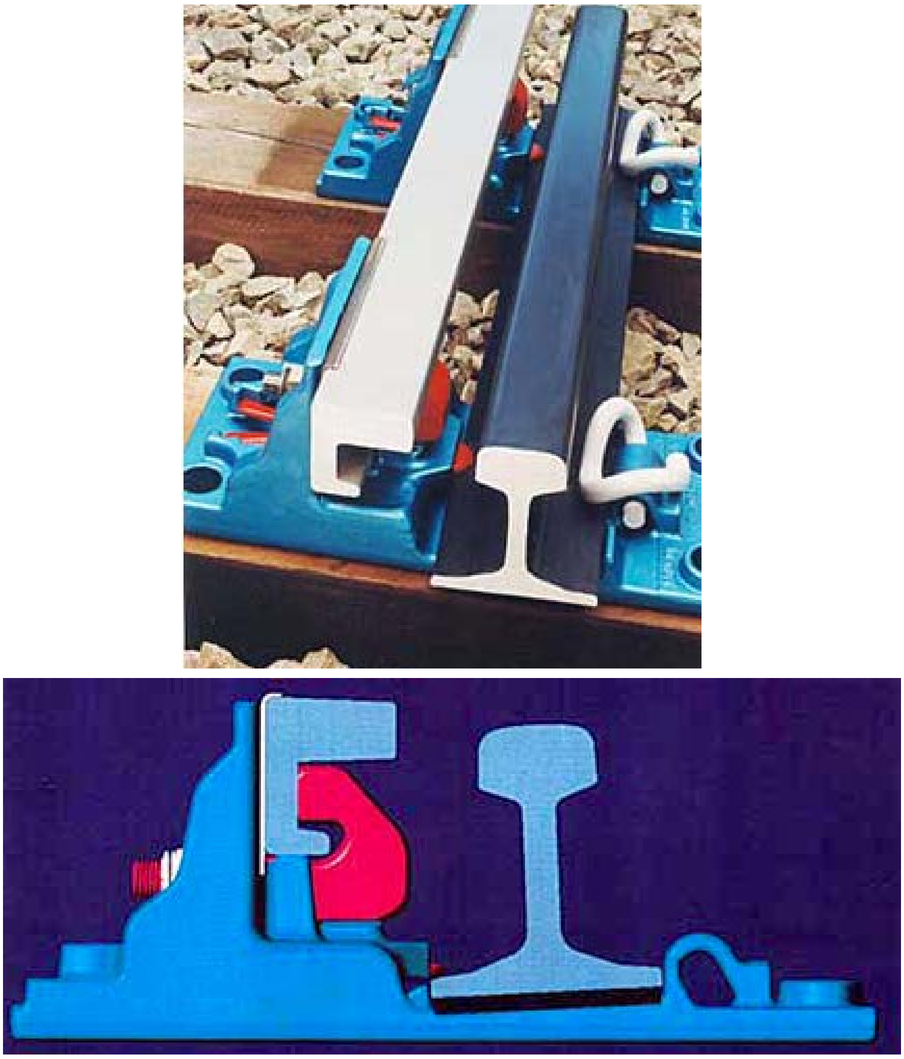
<> bring the rail grid on a proper stable ballast cushion and well bearing formation.

Check-rails are not clamped onto the sleepers or bearing-plates by train-weight. The problem is a proper solid fastening. In UK still there are cast-iron chairs, first developed for double bull-headed rails and later modified for flat bottom-rails. Both, running and check-rail are clamped with a cotter or wedge (wooden wedges or spring steel cotters) in the same cast-iron compound chair, separated by a check rail-block. Running and check-rail form a stable unit; see B.L. Gupta, A. Gupta, ***RAILWAY ENGINEERING***, Standard Publishers Distributors, Delhi, India, 2005, ISBN: 81-8014-011-3, page 2.103, Fig. 8.12:



Running-Rail and Check-Rail Fixation on a Cast Iron-Chair with Check-Rail Block and Cotter; UK

The Swizz turnout manufacturer ***SCHWIHAG*** has evolved for UK an intelligent solution to harbour running rail and guard/check-rail together on one cast iron-chair base-plate. The guard/check-rail is clamped to the chair with a clip:



Schwihag Clip-Fixation of Guard/Check-Rail

In Sri Lanka curve-check rails make sense on the gruelling broad gauge (1676 mm) upcountry line to mitigate the risk of a derailment on the tight curvatures of up to 18 Degree. The Sri Lanka Railways (SLR) upcountry line is unique around the globe for its

Indian broad-gauge track climbing over tight curvatures of up to 18 Degree curvature to nearly 2000 m above sea level. In India broad-gauge curvatures are restricted to 10 Degree.

Recently upcountry sections have been renewed with new Indian trough steel-sleepers and Pandrol Fast-Clips. Running and check-rail are clamped by the fast-clips with distance cast-iron block in between. The solid distance block secures the correct flange-way clearance. The compound behaves as ***ONE RAIL***. **Drilling of holes in the running rail for distance-bolts or blocks are avoided**.

If the running tables of the low-rail or inner curve-rail are run down the wheel flanges will ride on the check-rail blocks of fishplate-bolts and nuts, as the following pictures delineate:

Check-Rail on worn inner Curve Rail with Check-Rail Block and Pandrol-Fast-Clip on Trough Steel-Sleeper. Wheels riding on the Check-Rail Blocks and Wheels cutting into the Fishplate Bolts.; Hatton Section, Rozella

The elder method had been to fasten the curve check-rail on the running rail with check-rail bolts and spherules without distance blocks. But the optimal flange-way clearance cannot be secured. Bolts get elongated or become loose, and the curve check-rails loose their task to prevent derailments.

In calculating the optimum compromise for the flange-way clearance the trackman should well know about the wheel dimensions and wheel dimension tolerance, the dimensions of the WHEEL-BACK to WHEEL-BACK plus effective FLANGE-THICKNESS. He should take also into consideration the gauge-widening, the wheel-span and curve-tightness and the angular trailing of wheels (see Friedrich Krüger in EI-Eisenbahningenieur, Febr. 2011, page 6 and Rainer Fleiss, ibid, July 2008, page 17; VDEI Service GmbH, Berlin, Germany), and as well the tolerances and wear norms of wheel and rail profiles.

In India a common rule for the flange-way width is:

44 mm plus at least half the amount of the actual gauge-widening;

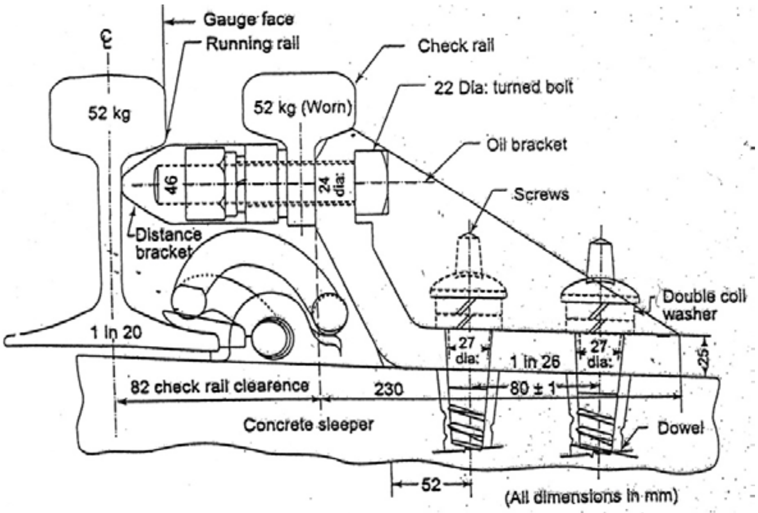
see J.S. Mundrey, ***RAILWAY TRACK ENGINEERING***, 4e, Tata McGraw Hill Education Private Limited, New Delhi, India, 2010, ISBN (13): 978-07-068012-8, page 187.

On the short welded Sri Lanka Railways (SLR) mainline-tracks the curve check-rails have only an alibi function. The flange-way has to be kept wide; otherwise the wheel-backs would cut at higher speed into the check-rails and distort the check-rails. There is no contact between wheel-back and check-rail. Here the check-rail has no function. The Check-rails are not fixed to the sleepers but fastened with a clip-screw system to the bottom of the running rail. In case of a derailment this weak fixation might burst off:

Curve Check-Rail on a Curve of the SLR Short Welded Rail (SWR) Main-Line Track; without any Function

Curve Check-Rail with wide Flange-Way Clearance on a Curve of the SLR Main-Line without any Function

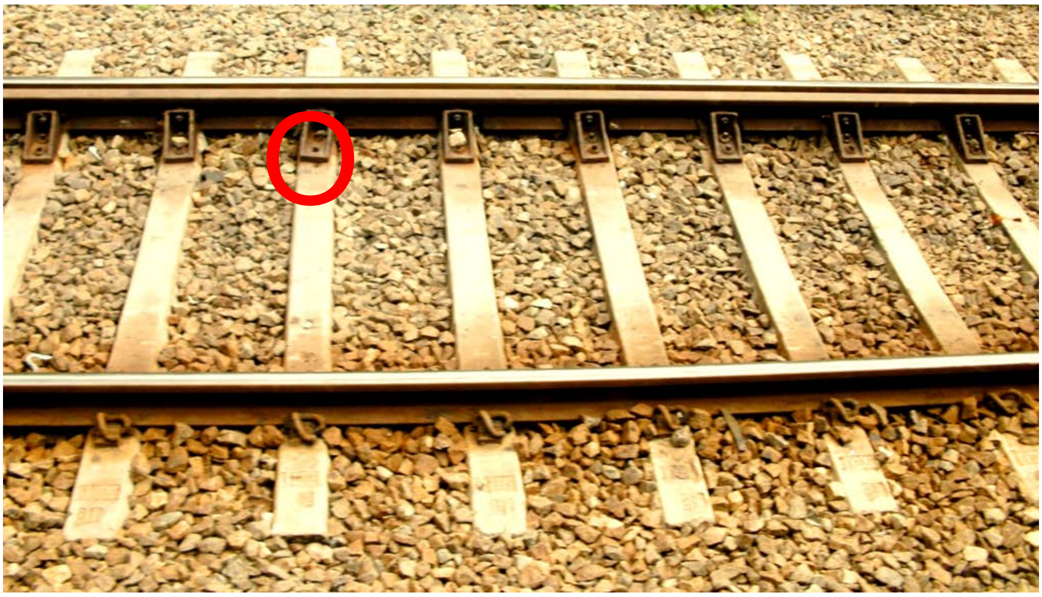
On the upgraded SLR Coast-Line the Long Welded (LWR) curves had been originally provided with check-rails, prepared with used rails and fixed with the Indian Bracket-Fastening System:



Indian Bracket-Fastening System for Check-Rails on Concrete-Sleepers with Dowels and Screws

Dowels in Concrete-Sleepers for Indian Check-Rail Bracket-Fastening

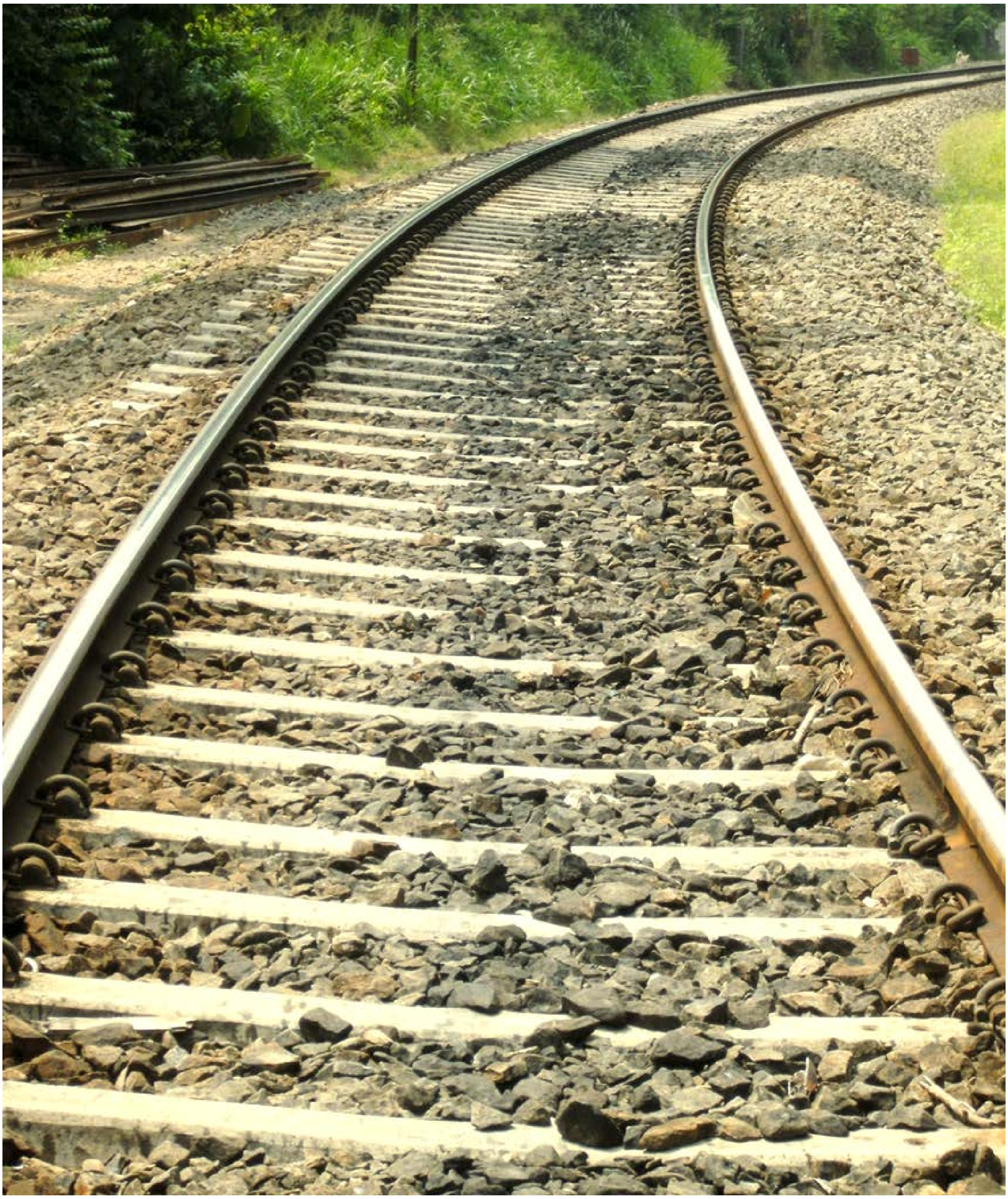
In order to fix used rails with the bracket system, recesses have to be torched-off from the rail-foot.



Bracket-Fixation of Curve-Check Rails on Concrete Sleepers, India

This system needs constant repairs and maintenance. Screws get loose falling off from the dowels and brackets get loose as can be seen on the picture above.

In India on main-line curves with curve-check rails, for example on the famous 5 Degree Kollam (Quilon) Curve in Kerala, the speed is restricted to 20 to 30 kmph. In Sri Lanka trains had been allowed to negotiate the check-rail fitted upgraded 5 to 6 Degree curves with 60 to 65 kmph. Train Drivers do not stick to this restriction and go sometimes over such curvatures with up to 80 kmph with the result that the wheels have cut in the check-rails, which by the strain got severely distorted and damaged. Therefore after a short period, the check-rails had to be taken out:



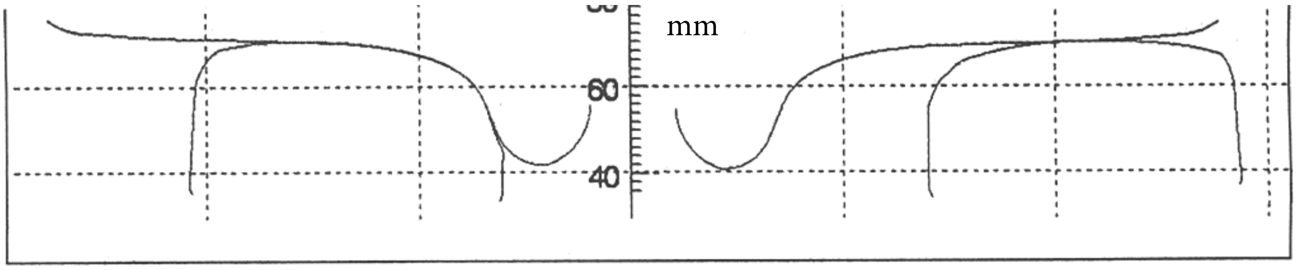
6 Degree Curve at Andadola after Removal of Curve Check-Rails; see discarded Check-Rails in left Corner above

Proper aligned curves with proper profiled rails on a stable cross-tie grid DO NOT NEED CURVE CHECK RAILS. Continental European and USA Railways know, why they DO NOT USE CURVE CHECK RAILS.

If a brake shoe might fall in the gap between running rail and check rail, this might cause a derailment.

Applying a high-performance lubrication medium can keep friction in a curve at the interface between wheel-flange and gauge-face as low as practicable. Curve-friction by angular wheel-trailing and wheel-slip can be reduced by **TOP-OF-RAIL LUBRICATION** with Friction Modifiers. Rolling Contact Fatigue can be substantially reduced. Hence the train curve-resistance is lowered.

By **PREVENTIVE & TARGET RAIL GRINDING** the optimal rail-profiles for outer and inner curve-rail can be reached; see Dr. W. Schoech, SPENO, Switzerland in ***RAILWAY GAZETTE***, Jan. 2012, p.47; for more details see also **Chapter 2.24** in ***INDIAN RAILWAY TRACKS a Track Engineering Compendium,*** which one can find for download under http://www.drwingler.com under ***Publications***:



Optimal Curve-Rail Profiles by Target Rail-Grinding

For automatic **RAIL LUBRICATION** see: LB Foster Friction Management, USA, L.B. Foster Rail Products www.lbfoster-railproducts.com/ , download brochure on ***FRICTION MANAGEMENT***; see also Chapter 2 in ***INDIAN RAILWAY TRACKS,*** which you find for download on http://www.drwingler.com . On the affixed **ANNEXURE** of this paper you will find the Chapter 3.8.1 on ***UNSYMMETRICAL RAIL PROFILES IN TIGHT CURVES*** from the ***TRACK COMPENDIUM*** of B. Lichtberger, Eurail press, Hamburg, Germany, ISBN978-7771-0421-8; and in the **Annexure** more pictures of curves sans check-rails.

Automatic Wayside Top-of-Rail Lubrication with a Friction Modifier, LB Foster

Automatic Wayside Running-Corner Lubrication, LB Foster

The rail-wheel interacting forces should be well understood. Track men and Rolling Stock men have to work together as a united team to solve the problems of friction in curves. In Sri Lanka mostly both think only about their own worries, and both do not feel mutual responsible for the overall best result.

A train runs with a **RESISTANCE** through a curve. The so-called **CURVE-RESISTANCE** is caused by additional friction between wheels and rails; see J.S. Mundrey, ***RAILWAY TRACK ENGINEERING***, 4e, Tata McGraw Hill Education Private Limited, New Delhi, India, 2010, ISBN (13): 978-07-068012-8, page 6.

SLR Track men doe not think so much about **Curve-Resistance**, only the Loco Drivers, when traction wheels are slipping on wet upcountry gradient curves.

The **FRICTION** causes **WEAR AND TEAR** of both **WHEELS** and **RAILS.** Where rails get worn, also wheels get worn!! Wear and Tear is a mutual interactive process.

Worn wheel-profiles, as there are hollow tyre, thin flange, sharp flange, worn/deep root, or deep flange increase the friction and hence the train resistance. This means, by keeping the wheel-profiles properly shaped the Rolling Stock Engineers can do a lot to reduce **WEAR AND TEAR** and to minimize **DERAILMENTS:** see **Chapter 20** in ***INDIAN RAILWAY TRACKS*** in http://www.drwingler.com **under *Publication*.**

On upcountry running rolling stocks one can detect often worn/deep flange-roots and hollow wheel-tyres, and hence **DERAILMENTS BY LOW SPEED FLANGE-CLIMBING are frequent! But who in Sri Lanka checks regularly the wheel-profiles of upcountry trains??**

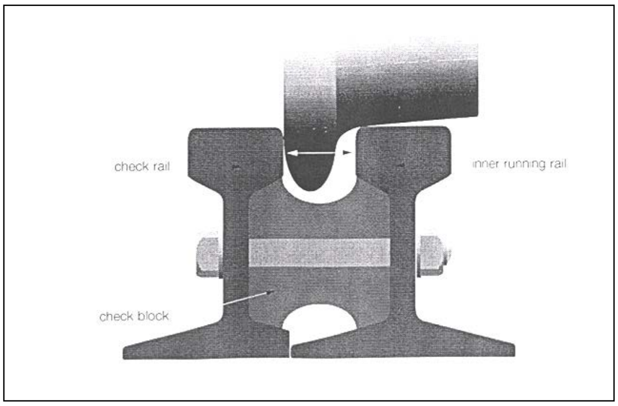
***By the way*, insufficient high rail-lubrication in conjunction with train set jerks can contribute to low speed flange-climbing derailments.**

The **LOW SPEED FLANGE-CLIMBING DERAILMENT** pattern had been extensively studied in Germany and Switzerland after some mysterious derailments on cross over turnouts of the ***GOTTHARD*** Alpine Line and after a spectacular derailment of a ***HIGH SPEED TRAIN*** at 25 kmph on the Cologne Rhine Bridge in Germany.

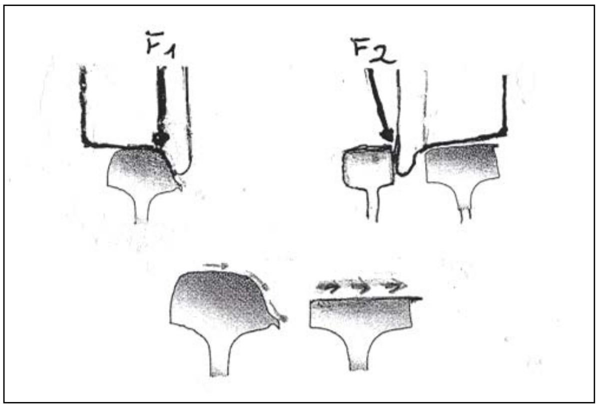
The author was in the Coach of the ***DARJEELING RAILWAY*** in INDIA, when a flange climbing derailment occurred on a down gradient run on a transition for a reverse S-bend. There had been a jerk, because the front loco applied the loco-brake and the brake man did not operate the manual coach-brake accordingly to stretch the train set. Typically not the first but the second running coach bogie derailed with the rear axle. The Indian IPW, who rushed to re-rail the coach, did not understand the derailment pattern. Later the author had discussed this with a Consultant in Delhi, and he understood.

If the wheels are guided round the curve by check-rails with a narrow gap or flangeway-clearanc, the wheels are hindered to make the full use of the conicity to compensate the different length of high and low-rail (gain of the inner rail over the outer rail on a curve; see: J.S. Mundrey, ***RAILWAY TRACK ENGINEERING***, 4e, Tata McGraw Hill Education Private Limited, New Delhi, India, 2010, ISBN (13): 978-07-068012-8, page 187). This causes additional friction on the running rail-table, mostly on the inner curve-rail. The friction caused by the back-face of a wheel scrubbing vertical against the check-rail of the inner curve or low-rail is higher than the friction caused by the outer wheel-flange rolling against the running corner of the outer curve or high-rail.

Curve check-rails with a tight flange-way clearance, in order to guide the wheels around the curve and in order to reduce the friction and wear on the high or outer curve-rail, increase the overall TRAIN CURVE-RESISTANCE. The wear of the high rail is reduced marginal for a high prize! **Under certain circumstances the wear on the running table of the low or inner curve-rail may be higher**



Hindered Use of the Conicity by Check-Rail



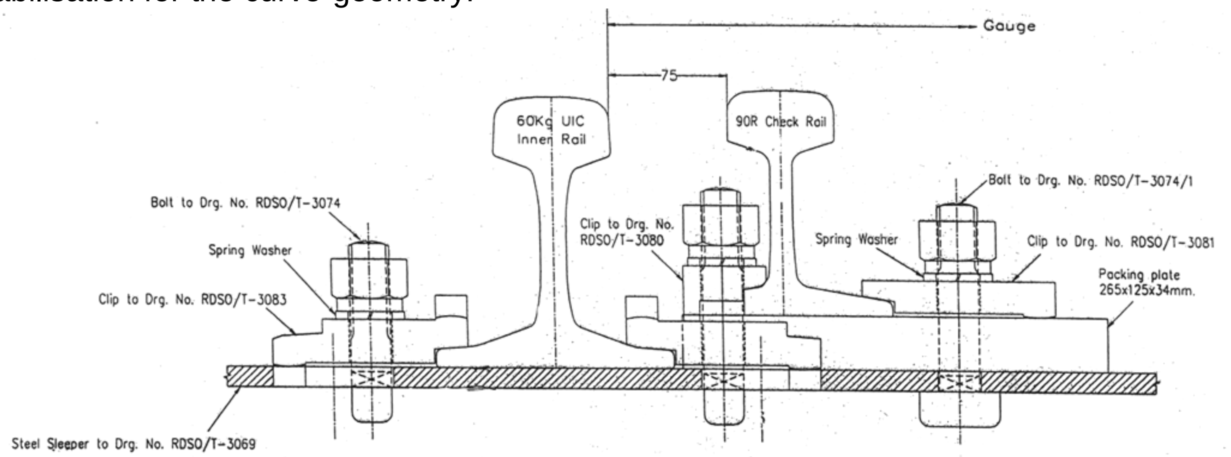
Friction at Check Rail (F2) & outer Curve Rail (F1); F2 > F1; Wear on outer and inner Curve-Rails

Upcountry, where by a tight flange-ways curve check-rails are used to guide the wheels round the curve, the running table of the inner curve rail gets heavily worn and flattened – and vice versa the wheel treat profiles get also worn correspondently. The latter should not worry the track men, if he feels not much responsible for the wellbeing of the rolling stocks. But the worry will come soon or later by **DERAILMENTS**. In Sri Lanka the most **DERAILMENT PRONE LINE is the gruelling HATTON SECTION**!

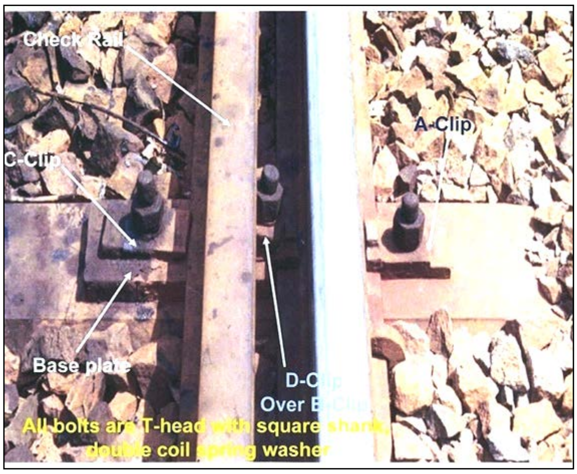
The author visited 2011 in India the mountainous heavy-haul freight tracks in Andhra Pradesh, Orissa and Chhattisgarh to learn more about Curve Check-Rails.

The so-called ***"KK Lines***" for 4000 to 8000 tonne Iron and Manganese-Ore hopper-trains climb up from two sides (from Visakhapatnam and from Raygada) by 800 m to Kirandul with more than 200 bridges and 100 tunnels over up to 8 Degree Curves with a ruling gradient of 1 in 100 to a mining field at Kirandul in the State Chhattisgarh. The ore-hopper trains are up to 1.5 km long hauled by six 6000 hps electric locos. Originally the track had been build in the 1960-ties with Japanese Engineering on wooden and steel sleepers with 13 m long fishplate jointed rails. Nowadays after formation rehabilitation and manual ballast deep--screening the rails are continuously Thermit welded on concrete sleepers, fastened with Indian Mark III ERC Clips; see the publication ***INDIAN RAILWAY TRACKS***, **Chapter 5** under http://www.drwingler.com.

12 years before curve check-rails against the risk of derailments had been fastened with bolts and nuts onto the trough steel-sleepers, **WITHOUT USING CHECKRAIL-BLOCKS OR DISTANCE-BOLTS** and **WITHOUT DRILLING HOLES IN THE RUNNING RAIL.** This rigid fixation of a check-rail on trough steel-sleepers had provided an additional stabilisation for the curve-geometry:



Fixation Details of Check-Rails on Trough Steel-Sleeper on Heavy-Haul KK-Line, India



Rigid Bolt Fastening of Check-Rail on Trough Steel-Sleeper, KK-Line, Orissa, India
Pict.: Courtesy of S. Raho

The check-rails laid with the prescribed flange-way clearance of 75 mm should perform the function to prevent vehicles from derailments. Within the last 12 years, the track had been upgraded with concrete sleepers and converted to a continuous welded track with new points on heavy duty concrete sleepers. The best welding result gives FLASH BUTT WELDING. Japanese assisted GAS PRESSURE WELDING and THERMIT WELDING, if not excellently performed, led to poorer result. Although with the CWR the check-rails have become superfluous, the ***"HOLY COW"*** had been again screwed on the concrete sleepers.

On the KK Line CWR-track there are now nearly no derailments any more. But the maintenance of the check-rails, fixed with the bracket system, is poor. The bracket holders are corroded, dowel-bolts have fallen off and plate grip expansion screws got missing or loose.

Worldwide Curve Check-Rails are nowadays not used on heavy-haul lines, because this would result in additional **TRAIN-RESISTANCE.** When summed up by 100 to 300 wagons this becomes a serious traction matter.

Curve on Heavy-Haul BSNF Rail Road in USA – No Check-Rails

<u>FAZIT:</u> AN APROPRIATE FRICTION MANAGEMENT IS THE BETTER SOLUTION THAN FIXING CHECK-RAILS IN CURVES!

Revised, August 2016

From B. Lichtberger, ***TRACK COMPENDIUM:***

3.8.1 Unsymmetrical rail profiles in tight curves

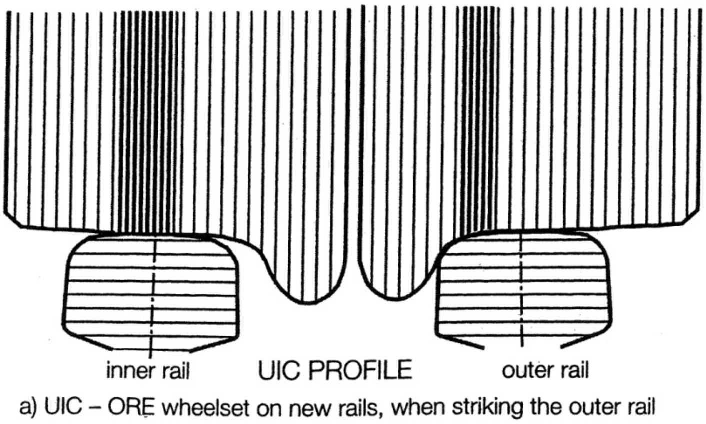
In curves the distance covered by the outer wheel is longer than that of the inner wheel. This difference in length is usually compensated by the different rolling radii (conical inclination of the wheel profile). When the outer wheel strikes the head of the rail on the outside of the curve, the contact patch is situated on top of the cone with the greatest radius. If this difference is no longer sufficient in small radii curves (200–400 m), the inner wheel begins to slip. As the wheels are firmly connected with each other and because of the centrifugal curving forces, the inner wheel has less traction compared to the outer wheel. The wheelset begins to adapt to a rolling radius which is different to the track. A striking angle is formed at the contact patch between the wheel surface and the tangent to the rail head surface. That is why so-called wheel slip marks develop on the lower rails. These wheel slip marks have wavelengths of 100–180 mm and defect amplitudes of approximately 0.5 mm.

To avoid this dynamic interaction between wheel and rail and the subsequent increased stress to track and noise development, rails are ground. After several months, however, these slip marks will reappear and the maintenance cycle has to be repeated.

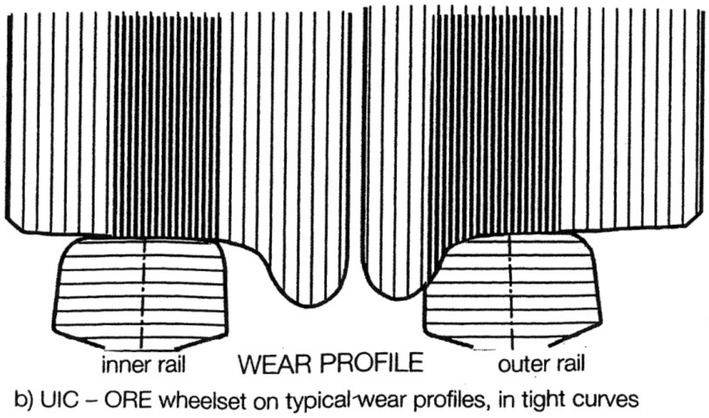
In tight curves (< 500 m) rail profiles wear in a characteristic way. The upper rail is subject to side wear due to the striking wheel flange, and the lower rail is heavily flattened, the rolling surface becomes broader and this reduces the difference between rolling radii. In the course of time burrs (laps) develop on both sides of the rail head due to plastic deformations. Lateral force and striking angle determine the extent of lateral wear to the wheel flange front and the rail head.

Unsymmetrical rail profiles are used because they adapt better to the circumstances and achieve a longer service life of the rail [84]. They are produced by grinding the rail head. The change in contact geometry and the subsequent equivalent conicity is safe, even from the point of view of a derailment, in the low speed ranges permitted through tight curves (< 100 km/h).

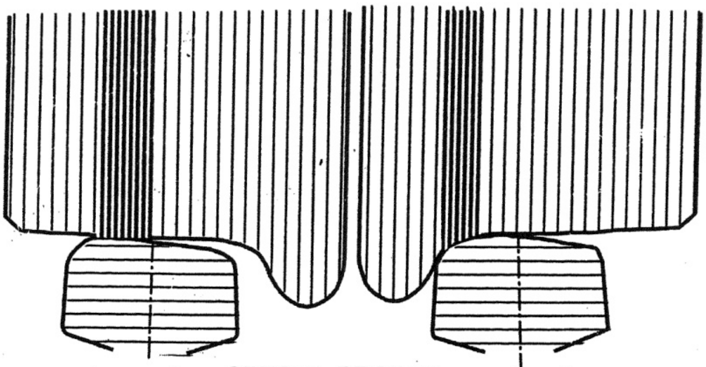
On the high rail the contact area between wheel and rail is ground as close as possible to the rail edge, on the lower rail it is moved as far away as possible. This is equivalent to an artificial increase between the rolling radii and a reduction to the striking angle.



a) UIC – ORE wheelset on new rails, when striking the outer rail



b) UIC – ORE wheelset on typical wear profiles, in tight curves



c) UIC – ORE wheelset on special-profile rails, in tight curves

Figure 52: Unsymmetrical rail profile compared with new rails and typical wear profiles

The use of unsymmetrical rail profiles in tight curves has the following advantages:

- increased service life of the rails,
- reduction of maintenance costs by decreasing the quantity of slip marks, reducing lateral wear and lateral guide forces [85]

3.8.2 The convex rail for the improvement of the running behaviour of railway vehicles

The objective of the modified head geometry of the UIC60 rail ("convex" rail, see diagram below) is to improve the contact geometry conditions between the wheel and the rail. One aim is the correction of gauge narrowing (track gauge < 1433 mm) which, in the case of wheel wear profiles, can frequently lead to instabilities in the vehicle running behaviour. Furthermore, the increase in the rail head edge radius leads to a reduction in the number of head checks caused by rolling contact fatigue. Development work began on the ball-shaped rail in Austria in 1998. Similar rail profiles optimised for their contact geometry were developed in Germany.

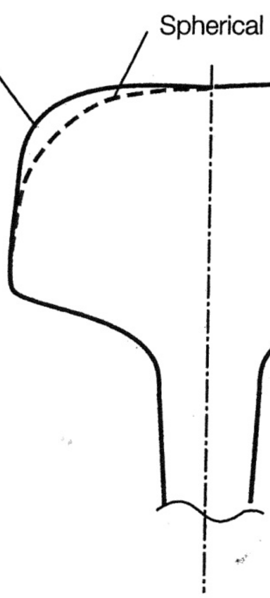


Figure 53: Schematic representation of the UIC60 standard profile and the "convex" UIC60 rail

From : B. Lichtberger TRACK COMPENDIUM, 2011 Eurailpress, Hamburg, Germany, ISBN 978-3-7771-0421-8; page 99/100

Picture Gallery - Tight Curves without Check-Rails

Croatia

Cumbres & Toltec Scenic Railroad; tight Fish-plated Curve, USA