Track friendly vehicles
- principles, advantages

Sebastian Stichel
August 8, 2007
What is track friendliness

A track friendly vehicle is a vehicle that causes low maintenance costs on the track (*and on the vehicle*) and enables trains to run on existing non-perfect track.
Advantages of track friendly vehicles

• Reduced track maintenance cost → allows lower track access charges

• Higher permitted speed in curves → reduced travel times
Bogie design for track friendly vehicles

Conventional stiff bogie:

Track friendly bogie:

- Lateral track damage is a function of curving performance.
- Curving performance is a function of primary plane stiffness and bogie wheelbase.
  - Low yaw stiffness in bogie
  - Optimize damping.
- Vertical track damage is among others a function of axle load
  - Light vehicles with moderate axle loads
Radial self-steering bogies
Limitations

- A soft wheelset guidance, without adequate damping, will usually exhibit undamped lateral oscillations (instability or hunting) already at quite low speed (below 100 km/h). There is a certain conflict between curving ability and dynamic stability.

  → The stiffness must not be too low
Passenger and commuter cars
375 cars

Radial self-steering bogies desired by the former Swedish State Railways (SJ) as a mean of reducing excessive wheel and rail wear.

Order placed with former ASEA (ABB -> Adtranz -> Bombardier).

From 1982 introduced on
- passenger cars (160 km/h)
- commuter cars (140-160 km/h);
Wheel wear - example

Wheel flange wear for two types of bogies (April-Sep)
- **STD** = standard “stiff” bogies
- **Asea** = Radial steering bogies, as tested by SJ
Fast regional trains
458 cars (end of 2006)

From 1999 introduced on motor coach trains
- Oeresund Train Unit (180 km/h) (DK, SE)
- Flytoget, Signatur & Agenda (210 km/h) (Norway)
- Regina (180-200 km/h) (SE)
High-speed tilting trains
230 cars and 44 power units

- From 1990 introduced on *X2000* tilting trains (200 km/h) in Sweden and China.
Regina 250

Passive bogie

Mechatronic bogie
Green Train

- Radial self-steering bogies of different guiding stiffness – ”soft” and ”medium”- are successfully tested in summer 2006 and 2007.
- Tests by multi-body simulation as well as on-track with instrumented force-measuring wheels.
- Stability criteria on straight track are met (with margin) with both ”soft” and ”medium” settings of wheelset guidance, at test speeds up to 281 km/h and eq. conicity up to ~0.3.
- Lateral track forces are typically 50 – 65 % of UIC limit values.
- Theory and simulations agree and have been favourably validated with on-track tests.
- Mechatronic bogie and active lateral secondary suspension tested in summer 2007
Development for higher speed and track friendliness

- Radial self-steering with optimum wheelset guidance and adequate yaw damping – to achieve both stability at high speed as well as a low wheel and rail wear on mainline Swedish track. "Soft" settings give the lowest wheel and rail damage (wear and rolling contact fatigue).
Active secondary suspension in trains

- **Active lateral suspension**
  - Improved lateral vibration comfort
  - Goal: Same ride comfort at 250 km/h as without active suspension at 200 km/h

- **Hold-off device**
  - to keep carbody in centred position in curves
    ⇒ Move in bumpstops
      → Wider carbody possible
      → Better cross wind stability
    ⇒ Improved lateral vibration comfort by softer secondary suspension
  ⇒ Possible to run at high speeds in curves
Differentiated track access charges dependent on the vehicle behaviour will be introduced on a number of European railway networks. This sharpens the need for "track-friendly" bogies.

Ongoing development seems to widen the application of self-steering bogies to higher speed (250 km/h and up). Many high-speed trains will be running on various track standards at various speeds, in particular tilting trains.

Actively controlled radial steering – "Mechatronic bogies" - is considered as an appropriate mean to achieve still higher performance and track-friendliness.

Active lateral suspension to further improve ride comfort, and to make higher speeds in curves possible.
Regina 250 for lower track access charges, shorter travel times and very good passenger comfort

- Step-by-step development for track friendly bogies

- Regina for 250 km/h Test 2007-2008
  Active radial steered, Mechatronic bogie

- Regina for 250 km/h Test 2007-2008
  Active lateral suspension, soft bogie

- Regina for 250 km/h Test 2006-2007
  Passive radial steered, soft bogie

- Regina for 200 km/h Used today
  Passive radial steered, soft bogie

Active lateral actuator