

What are the effects of maintenance costs when axle load is increasing?



Summary 32,5 ton axle load test train

- Start 2015-09-01 – status 2017-09-30
- No of trips 656 = 288.370 km/wagon
- Average axle load 31,0 ton vs. 28,6 ton standard train = 8 % increase
- Punctually = as standard train 72 %
- Energy consumption = 7,5 % higher with a train weight 6,5 % higher (4,90 vs. 4,56 MWh)
- Loading time = slightly longer due to weight adjustments when overloading
- Unloading = same as standard train

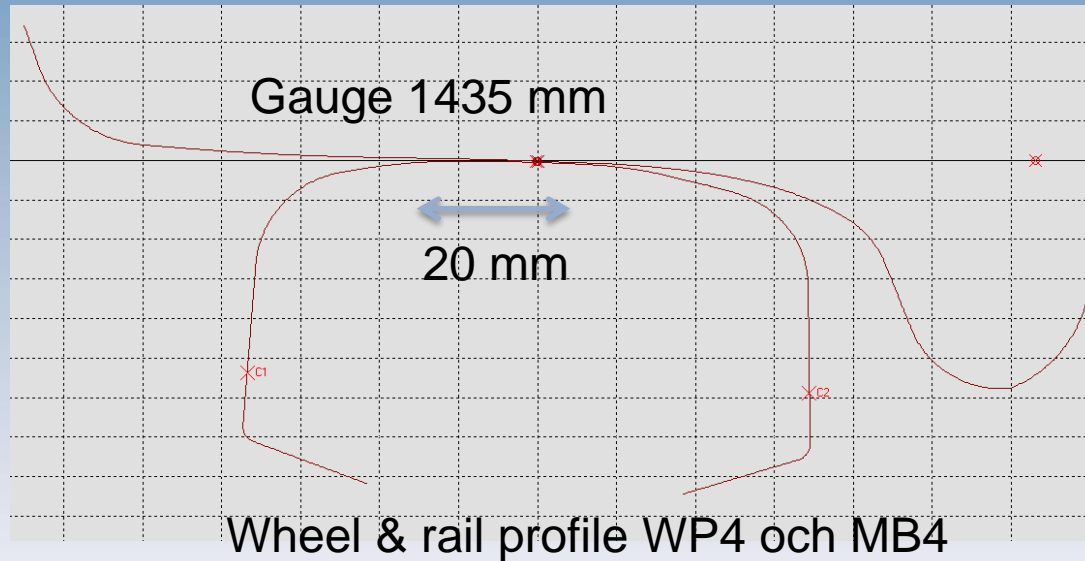
Summary 32,5 ton axle load test train

Maintenance

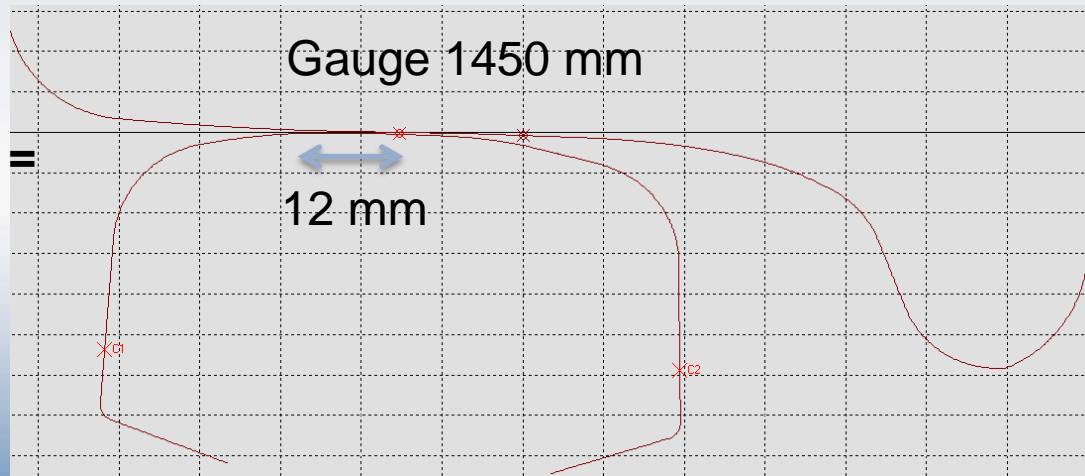
- No. of work orders are 9 % of total work orders for the wagon fleet and the test train wagons are 8 % of total fleet i.e. 1 % difference.
- Brake block wear 5 - 8 % higher than standard train. Linear with increased axle load.
- Wheel wear 5 - 8 % higher – linear to axle load
- Wheel axle exchange due to RCF 29 % higher frequency than standard train (55 vs 71 %).

Contact Stress Wheel & Rail - Wagon

**Normal gauge =
wide contact band =
low stresses =
mostly wear =
no RCF**



**Wide gauge =
narrow contact band =
high stresses =
RCF dominates =**



Contact Stress Wheel & Rail

From the Hertz' theory a formula for mean contact stress between wheel and rail can be formulated as:

$$\sigma_{mean} = \sqrt{\frac{\pi \cdot E}{64(1 - \nu^2)} \cdot \frac{Q}{rb}} \left[\frac{N}{mm^2} \right]$$

E = modulus of elasticity = 210 000 N/mm²

ν = Poisson's number = 0.3 for steel

Q = wheel load (15 or 16,25 ton)

r = wheel radius (Loco 625 to 575 mm, Wagon 458 to 429 mm)

b = half width of the contact area between wheel and rail

Contact Stress Wagon Wheel

Mechanical testing according UIC 812-3.
Requirements of the mechanical properties:

	YS _{0,2} (MPa) (Rp _{0,2})	UTS (MPa)	A %	Z %	KCU (J) + 20°C		KV (J) -20°C
Rim	≥ 630	1050 - 1150	≥ 11	≥ 20	Avg 3 test ≥ 10	Single result ≥ 7	For Information only
Web	≥ 390	≥ 150 *	≥ 11	≥ 20	N/A	N/A	For Information only

$\sigma_{mean} = 603 - 623$ Mpa with a contact band of 20 mm and 30 ton

$\sigma_{mean} = 777 - 808$ Mpa with a contact band of 12 mm and 30 ton

$\sigma_{mean} = 628 - 649$ Mpa with a contact band of 20 mm and 32,5 ton

$\sigma_{mean} = 814 - 841$ Mpa with a contact band of 12 mm and 32,5 ton

Summary 32,5 ton axle load test train

- If all trains, between Malmberget mine and Luleå harbor, should have had 32,5 ton axle load during this period of 25 months, the capacity would have been increased with 1,2 Million ton.
- The value for LKAB of 1,2 Million ton pellets is between 500 to 1.000 Million SEK.
- The increase in maintenance cost for the fleet would be about 5 MSEK/annum. Energy cost increase would be about 0,5 MSEK/annum.

Questions?

