

Maintenance Strategies for Turnouts

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Conference on Modern Technologies of Railway Turnouts
18 January 2018
Gdansk, Poland



Modern Railway Infrastructure means...

- Long service lives (open track >30a; bridge >80a; tunnel >100a)
- Availability
- Maintainability
- Sustainability
- Efficiency
- Interoperability
- Safety
- Competitiveness
- Reasonable costs



LifeCycleCosting

Costs of the materials used
 Costs for sub
 Costs
 Work-site length / Track closure times

Investment until next re-investment



Levelling – Lining – Tamping
 Maintenance
 Fast Cleaning
 Rail Grinding (side wear)

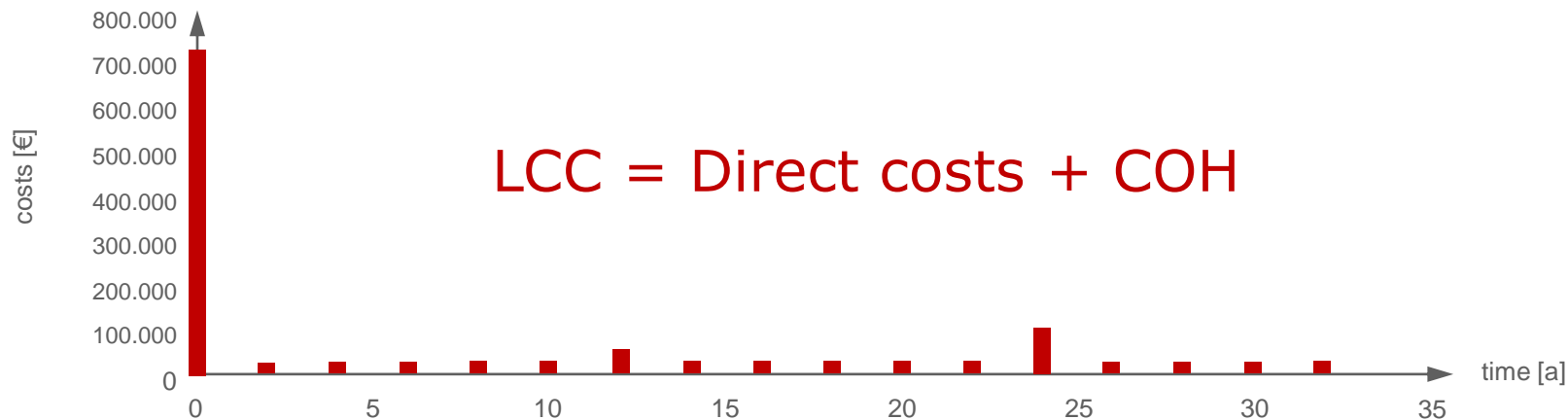
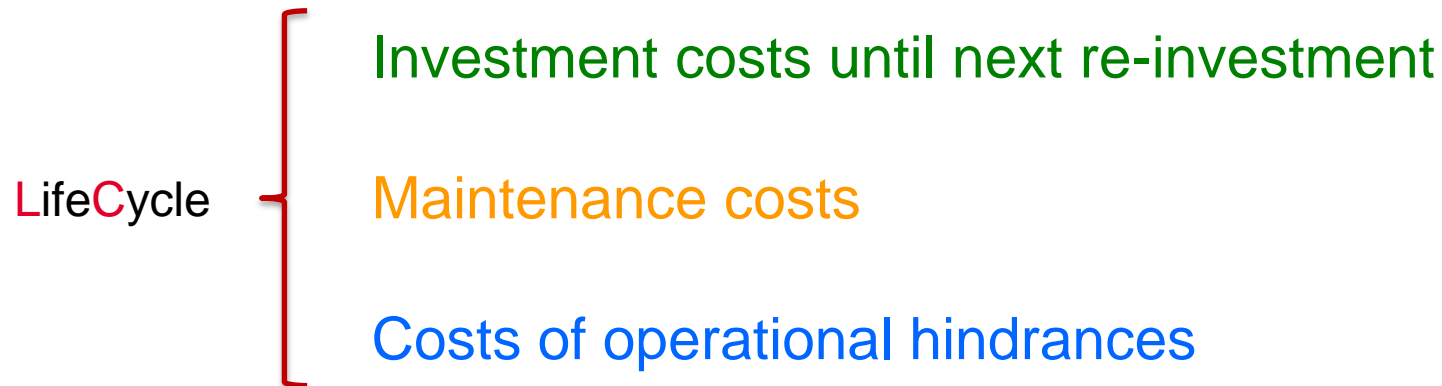
Delays and follow-up delays
 Rail replacement
 Train services
 Alternative routing

Costs of operational hindrances



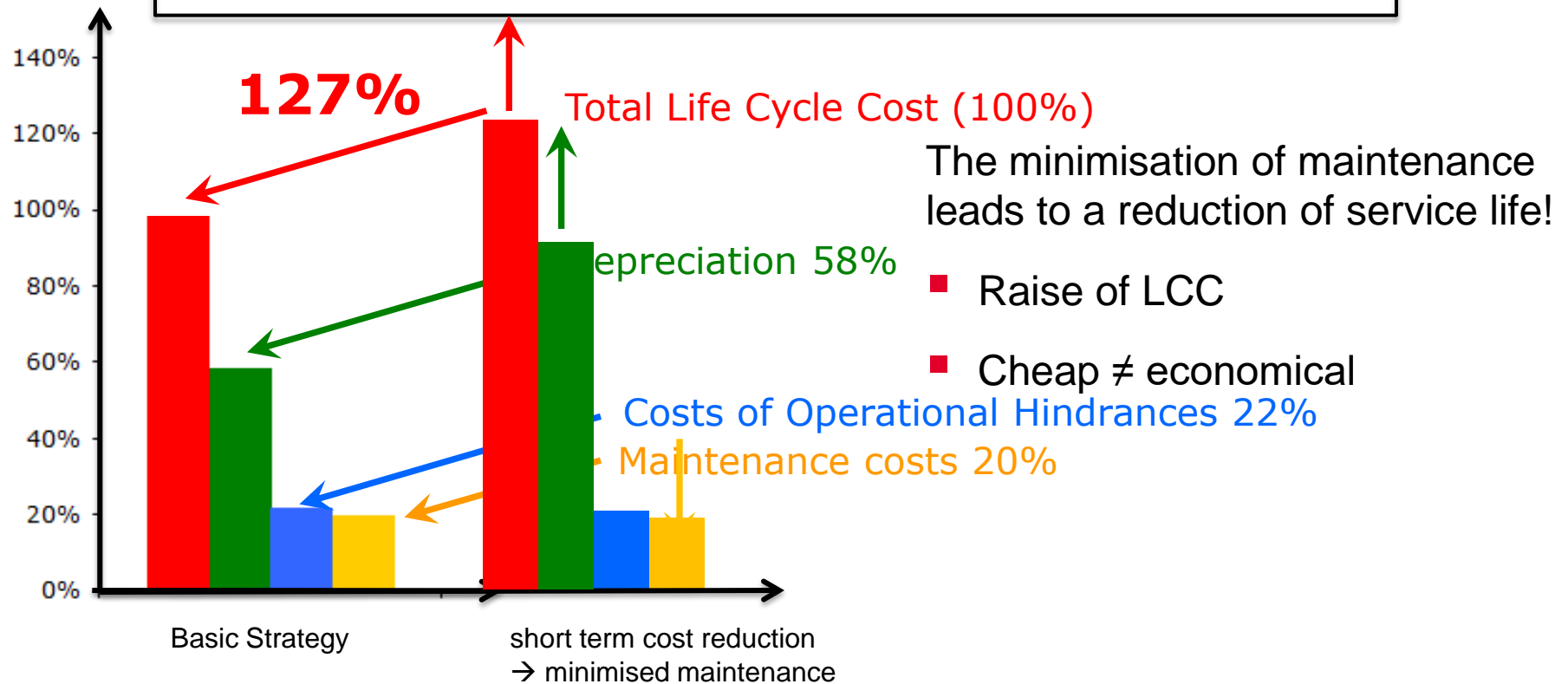
LifeCycleCosting

- Costs from asset construction until its recycling or deposing



LifeCycleCosting

$$\text{LCC} = \frac{\text{(Re)-Investment Costs} + \sum \text{Maintenance Costs} + \sum \text{COH}}{\text{Annual Costs} \times \text{Service Life}}$$



Transport volume >70,000 gross tons per day and track
Double tracked line, straight section

Turnout Strategy based on LCC – Technical Input

- First step of developing asset strategies → description of the existing assets
- Maintenance cycles and service life depend on several boundary conditions. The most important are:
 - Initial quality
 - Traffic load
 - Turnout track system components
 - Turnout design/turnout radius
- What are the values of these – so called – parameters?
- Starting on a strategic level, average figures are necessary

Turnout Strategy based on LCC – Technical Input

- Parameter values must be as detailed as necessary and as rough to emerge strategic decisions:
- Traffic load:
 - < 8.000 gross tons/day,track
 - 8.000 – 15.000 gross tons/day,track
 - 15.000 – 30.000 gross tons/day,track
 - 30.000 – 45.000 gross tons/day,track
 - 45.000 – 70.000 gross tons/day,track
 - > 70.000 gross tons/day,track
- New/old constructed track:
 - Old track, Speed < 200 km/h
 - New track, Speed \geq 200 km/h

Turnout Strategy based on LCC – Technical Input

- Parameter values must be as detailed as necessary and as rough to emerge strategic decisions:
- Turnout design:
 - Standard (straight) turnout
 - Curved turnout in small radii (600-3000m)
 - Curved turnout in very small radii (200-600m)
- Turnout radius:
 - R190
 - R300
 - R500
 - R760
 - R1200
 - 2600/1600

Turnout Strategy based on LCC – Technical Input

- Parameter values must be as detailed as necessary and as rough to emerge strategic decisions:
- Type of sleeper:
 - Wooden sleeper
 - Concrete sleeper
 - Concrete sleeper with under sleeper pads
- Rail profile:
 - 60E1
 - 54E2
 - 49E1

Turnout Strategy based on LCC – Technical Input

- Parameter values must be as detailed as necessary and as rough to emerge strategic decisions:
- Construction of frog:
 - Fixed frog
 - Moveable frog (compulsory for Speeds > 160 km/h)
- Type of frog:
 - Mn13 (not for 49E1)
 - FVC (just for 49E1)

Turnout Strategy based on LCC – Technical Input

- Each turnout is defined by a combination of parameters

→ These combinations lead to so-called “standard turnouts”

Westbahn ABS <200km/h	EW R=1200	double track		
gross tons/day&track	rail profile	sleeper	frog	substructure
90.000	60E1	concrete/usp	Mn/fixed	good

- Including:

- 6 ranges of traffic loads
- 2 track construction types
- 3 turnout designs
- 6 turnout radii
- 3 sleeper types
- 3 rail profiles
- 2 frog constructions
- 2 frog types

→ Already more than 7.000 standard turnouts

→ 80 standard turnouts describe the network quite well

Turnout Strategy based on LCC – Technical Input

- For each standard turnout a basic working cycle exists consisting all works executed within the total life span

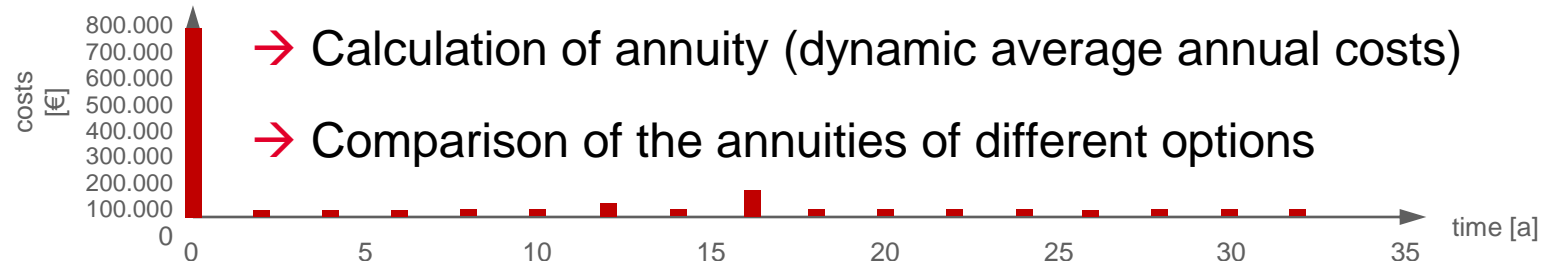
	service life	33,0	0	1	2	3	4	5	6	7	8	9	10	11		26	27	28	29	30	31	32
relaying of turnout	1,0	1																				
leveling-lining-tamping	5,5							1					1						1			
grinding	7,0				1					1				1			1					
exchange of half set of switches	2,0																					
exchange of frog	3,0										1					1						
exchange of checkrail	1,0																					
overlay welding/repair welding	3,0									1						1						
deburring	29,0		1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1
unplanned small maintenance	28,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5			1,5	1,5	1,5	1,5	1,5	1,5	1,5
ballast undercutting/cleaning	0,0																					
rail pad exchange	1,0																					
sleeper screw hole renewal	0,0																					
exchange of set of sleepers	0,0																					
exchange of single sleepers	0,0																					

Data:
specialist experience,
data warehouses

Turnout Strategy based on LCC – Economic Evaluation

- To calculate the Life Cycle Costs, it's only necessary to replace the amount by the specific costs

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gross tons/day&track	rail profile	sleeper	frog			substructure																													
90.000	60E1	concrete/usp	Mn/fixed			good																													
service life		33,0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
relaying of turnout		1,0	€																																
leveling-lining-tamping		5,5						€						€					€					€					€				€		
grinding		7,0				€				€				€					€				€				€				€				
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unplanned small maintenance		28,5	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€	€
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Turnout Strategy based on LCC – Basic Result

- Basic result of the actual turnout investment strategy (track system):

Transport Load [gross tons/day&track]	V [km/h]	Turnout Components
>70.000	≤ 160	60E1, concrete/USP, Mn fixed (moveable for special cases)
	> 160	60E1, concrete/USP, moveable
45.000-70.000	≤ 160	60E1, concrete/USP, Mn fixed
	> 160	60E1, concrete/USP, moveable
30.000-45.000	≤ 160	60E1, concrete/USP, Mn fixed
	> 160	60E1, concrete/USP, moveable
15.000-30.000	≤ 160	60E1(54E2*), concrete/USP, Mn fixed (* <u>or</u> depending on the long-term track components)
8.000-15.000	≤ 160	60E1(54E2*), concrete/USP, Mn fixed (* <u>or</u> depending on the long-term track components)
<8.000	≤ 160	49E1, wood, FVC fixed <u>or</u> rehabilitated

→ Sensitivity analyses (rate of interest, costs of operational hindrances)
don't change the result

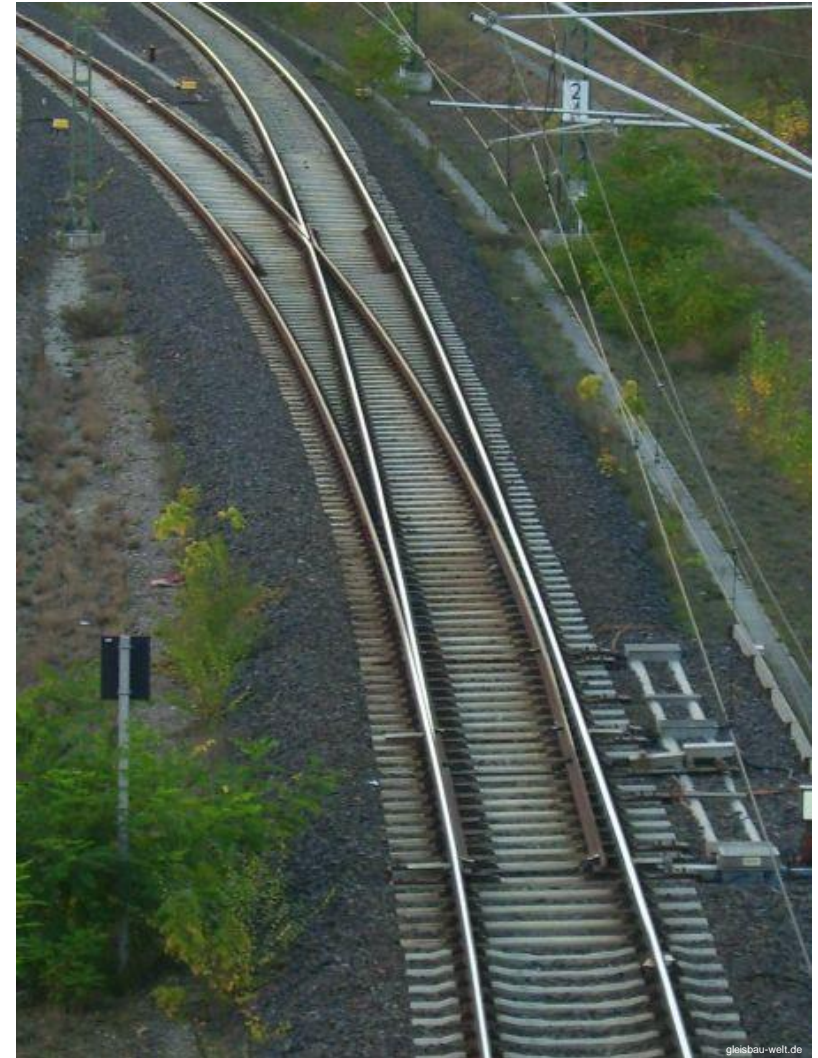
Turnout Strategy based on LCC – Special Evaluations

- Besides the base result of the investment strategy, there are covered several special evaluations answering individual maintenance or investment questions:
 - Curved turnouts
 - Sleeper screw hole renewal
 - First turnout service and ongoing periodical deburring
 - Switch rails with steel grade of 350HT
 - Moveable frog for turnouts in tracks with speeds lower than 200 km/h
 - Mn13 frog vs. Vario or FVC
 - Exchange of all sleepers

Turnout Strategy based on LCC – Special Evaluations

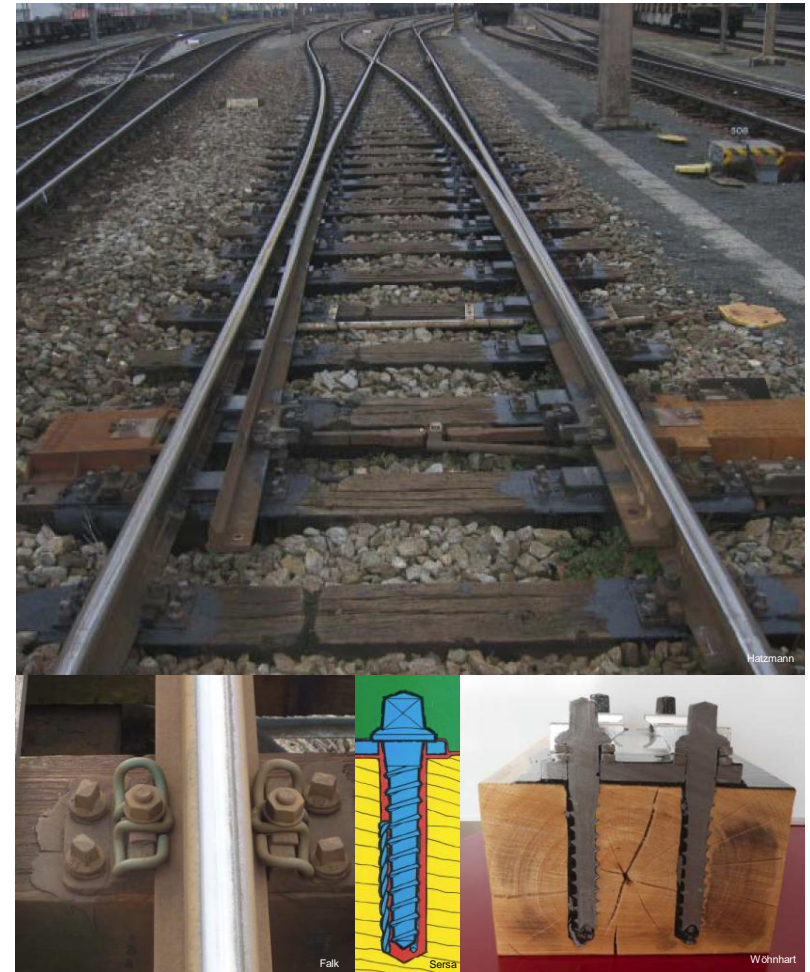
- Curved turnouts
 - In small radii (600-3000m):
+7% to +24% LCC to a straight turnout
 - In very small radii (200-600m):
+22% to +53% LCC to a straight turnout
- Avoid curved turnouts in new constructions
- But don't touch curved turnouts in existing alignments (critical costs [€]):

Standard Turnout	BWlv	BWsv
> 70.000	120.923	243.041
45.000-70.000	53.646	133.139
30.000-45.000	37.088	83.957
15.000-30.000	26.210	72.501
8.000-15.000	18.557	56.330



Turnout Strategy based on LCC – Special Evaluations

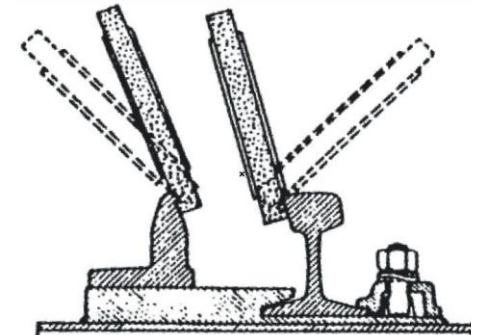
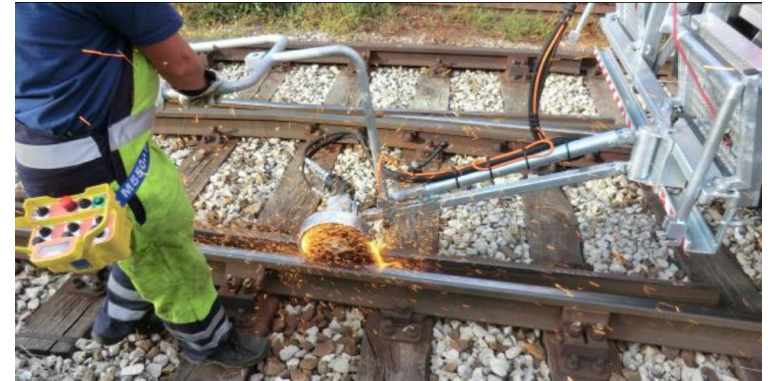
- Sleeper screw hole renewal (wood):
 - Economical action to reach the average service life for turnouts in tracks ≥ 45.000 gross tons/day
- Good alternative especially for reaching the same point in time for reinvestment of turnouts for entire station gridirons



Turnout Strategy based on LCC – Special Evaluations

- First turnout service and ongoing periodical deburring:
 - Economical solution for turnouts with track loads of more than 15.000 gross tons/day

- First turnout service (especially grinding, deburring of the frog and switch rails) after about 3 million gross tons and an ongoing deburring every 40 million gross tons



Turnout Strategy based on LCC – Special Evaluations

- Switch rails with steel grade of 350HT:
 - Recommended for turnouts in tracks with more than 8.000 gross tons/day

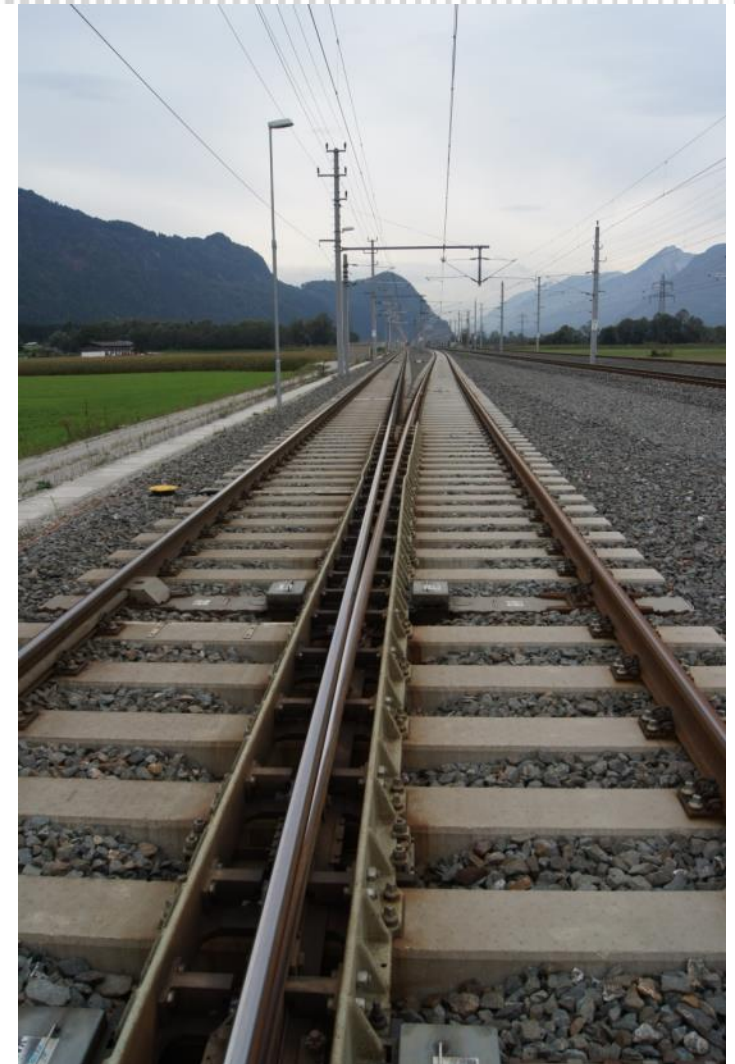
- Additional costs of switch rails with 350HT are out of all proportion to the risk of changing the switch rails (or one more)



Turnout Strategy based on LCC – Special Evaluations

- Moveable frog for turnouts in tracks with speeds lower than 200 km/h:
 - Possible economical solution for tracks with loads of more than 70.000 gross tons/day

- But: Just if there are no major (costly) changes in the control centre required!



Turnout Strategy based on LCC – Special Evaluations

- Mn13 frog vs. Vario or FVC:
 - Positive economic effect is on the side of Mn13 (vs. Vario), the more load the more Mn13 is economical
 - FVC: For turnouts in tracks with less than 8.000 gross tons/day
- Mn13: good-natured, lower risk (slow crack growth)



Turnout Strategy based on LCC – Special Evaluations

- Exchange of all sleepers (wood):
 - Recommended for turnouts in very low transport loads (<8.000 gross tons/day and track) after reaching their service life
- Only if the track of the turnout is in such a good condition that it will not reach its service life the following 17 years



- Strategic decisions concerning railway assets have to be based on Life Cycle Cost Analyses
- Results are:
 - Strategy for investment and re-investment
 - Maintenance/Repair strategy
 - Answers to special questions concerning investment and maintenance

Thank you very much for your Attention!

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