

REDUCING THE OCCURRENCES AND IMPACT OF FREIGHT TRAIN DERAILMENTS



D-Rail dissemination Meeting 12th November (STOCKHOLM)

WP 3 – Derailment analysis and prevention

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Speakers : Michel PINEAU (SNCF) & Anders EKBERG (CHALMERS)



1

Introduction

2

Participants & Roles

3

Deliverables

4

Results

INTRODUCTION



Deliverable Number ⁸¹	Deliverable Title	WP number ⁸³	Lead beneficiary number	Estimated indicative person-months	Nature ⁸²	Dissemination level ⁸³	Delivery date ⁸⁴
D3.1	derailment Causes, impact and prevention assessment	3	4	20.00	R	PU	10
D3.2	Analysis and mitigation of derailment, assessment and commercial impact	3	7	30.00	R	PU	18
D3.3	Guidelines on derailment analysis and prevention	3	6	21.00	O	PU	18

PARTICIPANTS & ROLES



- VUT Technische Universität Wien
- CHALM Chalmers Tekniska Högskola AB
- POLIM Politecnico di Milano
- MMU The Manchester Metropolitan University
replaced since July 2012 by
HUD Huddersfield University
- LUCC Lucchini RS SPA
- DB Deutsche Bahn AG
- HARS Harsco Rail Limited
- SNCF Société Nationale des Chemins de fer Français



POLITECNICO
DI MILANO



Task 3.1 – Analysis of derailment causes, impact and prevention assessment schemes

- Leader: VUT
- Participants: HARS

“top–down”

D3.1

Task 3.2 – Analysis & mitigation of derailment related to wheel/rail interaction

- Leader: POLIM
- Participants: DB, (MMU) HUD, CHALM, SNCF

“bottom–up”

**closely integrated
D3.2 and
D3.3 (guideline)**

Task 3.3 – Analysis & mitigation of derailment due to material fatigue & fracture

- Leader: CHALM
- Participants: LUCC, SNCF

“bottom–up”

all WP3 deliverables are public



Theme [SST.2011.4.1-3]
Development of the Future Rail System to
Reduce the Occurrences and Impact of Derailment



Development of the Future Rail Freight System to | Reduce the Occurrences and Impact of Derailment

D-RAIL

Grant Agreement No.: 285162 FP7 – THEME [SST.2011.4.1-3]

Project Start Date: 01/10/2011

Duration: 36 Months

D3.1

Report on analysis of derailment causes, impact and prevention
assessment

Due date of deliverable: 31/07/2012

Actual submission date: 30/05/2013

Work Package Number: WP3
Dissemination Level: PU
Status: Final F2

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D3.1 Analysis of derailment causes, impact and prevention assessment schemes

- **Cause-consequence chains** of different derailment causes
- Identification of **potential mitigation measures** including estimation of application level
- Overall **evaluation approach** for mitigation measures to make a cost-benefit-analysis for the implementation of on-board and wayside train monitoring systems.

DELIVERABLES



Exemple of content for D3.1

showcases for mitigation
measures for derailment
cause
axle rupture

T - trackside

V - vehicle side (in general)

R - vehicle side (recording car)

Y - (shunting) yard

W - workshop

a - widely known/used measures

b - already known measures, but
not widely applied

c - measures, which might be
relevant for the future

1...9 - technology readiness level
(TRL)

number of subcategory	subcategories of derailment causes	monitoring target	monitoring target type	T	T	T	T	T	T	V	V	Y	W	W	W
				axle load checkpoint (Q)	axle load checkpoint (Y and Q, resp. Y/Q)	wayside crack detection	hot box detection (infrared-based)	acoustic bearing detection	vehicle profile measurement	acceleration/force measurement (vertical)	stress detector	visual inspection	visual inspection	ultrasonic inspection	magnetic particle inspection
1	axle rupture (in general)	cracks on axle	preceding causes			c							a	b	a
						-							g	g	
						2							g	g	
2	axle rupture (in general)	faulty running surface	preceding causes	a	b					c		a	a		a
				8	8								g	g	
				7	-					-		g	g		
				5	1					2		g	g		
3	axle rupture (in general)	faulty suspension	preceding causes	a	b				b		c	a	a		
				8	8				6						
				9	-				9		-	g	g		
				5	1				1		2	g	g		
4	axle rupture (in general)	faulty frame	preceding causes	a	b					c					
				-	-										
				9	-						-				
				5	1						2				
5	axle fatigue	overloading	preceding causes	a	b					c					
				9	9										
				9	-						-				
				5	1						2				
6	axle fracture	overloading	preceding causes	a	b					c					
				9	9										
				9	-						-				
				5	1						2				
7	axle rupture due to thermal stress	faulty bearings (before overheating)	preceding causes					b							
								-							
								-							
								5							
8	axle rupture due to thermal stress	faulty bearings (overheated bearings)	preceding causes					a							
								9							
								9							
								9							

DELIVERABLES



Theme [SST.2011.4.1-3]
Development of the Future Rail System to
Reduce the Occurrences and Impact of Derailment



Development of the Future Rail Freight System to Reduce the Occurrences and Impact of Derailment

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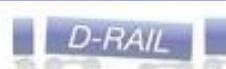
D3.2

Analysis and mitigation of derailment, assessment and commercial impact

Due date of deliverable: 31/03/2013
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(15/11/2013 rev after int & ext review)

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Theme [SST.2011.4.1-3]
Development of the Future Rail System to
Reduce the Occurrences and Impact of Derailment



Development of the Future Rail Freight System to Reduce the Occurrences and Impact of Derailment

D-RAIL

Grant Agreement No.: 285162 FP7 – THEME [SST.2011.4.1-3]

Project Start Date: 01/10/2011

Duration: 36 Months

D3.3

Guidelines on derailment analysis and prevention

Due date of deliverable: 31/03/2013
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Work Package Number: WP3
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DELIVERABLES



D-RAIL D3.2 Analysis and mitigation of derailment, assessment and commercial impact

Table of Contents

1	Introduction	10
2	Common vehicle	11
2.1	Model parameters	11
2.2	Benchmark	11
2.2.1	Benchmark track case	11
2.2.2	Benchmark results	12
2.2.3	The influence of chassis torsional flexibility	12
3	Derailment due to flange climbing in line operations	18
3.1	Influence of vehicle parameters on derailment	19
3.1.1	Simulation analysis	19
3.1.2	Configuration of vehicle models	20
3.1.3	Results – influence of vehicle parameters on derailment	26
3.1.4	Conclusions – influence of vehicle parameter variation on derailment	67
3.2	Influence of suspension failure and faults on derailment	79
3.2.1	Simulation analysis	79
3.2.2	Configuration of vehicle models	79
3.2.3	Results – Suspension failure and faults	77
3.2.4	Conclusions – Suspension failure and faults	90
3.3	Influence of isolated track defects on derailment	91
3.3.1	Study on existing track defect amplitudes in dependency on defect length	91
3.3.2	Influence of rail track defects and their length on the derailment risk	95
3.3.3	Conclusions – isolated track defects	104
3.4	Concluding remarks	106
3.4.1	Identified main affecting parameters	106
3.4.2	Recommendations	106
3.5	References	109
4	Derailments in switches & crossings	110
4.1	Background	110
4.2	Literature survey	110
4.2.1	Derailment in turnouts	110
4.2.2	Other literature	111
4.2.3	Standards	111
4.3	Studied derailment scenario	111
4.3.1	Motivation of derailment scenario	111
4.3.2	Optimisations	112
4.4	Simulation Procedure	113
4.4.1	Task 1 Sensitivity studies to find key influencing parameters	113
4.4.2	Task 2 Evaluation of current standards	113
4.4.3	Task 3 Limit states as a function of key influencing parameters	113
4.4.4	Task 4 Comparison to standard rails	113
4.4.5	Task 5 Vehicle parameter limits	113
4.5	Numerical simulations	114
4.5.1	Simulation model	114
4.5.2	Investigated parameters	115
4.5.3	ODE methodology	117
4.5.4	Objectives	119
4.5.5	Load Cases	119
4.5.6	Overview of parameter study	122

D-RAIL D3.2 Analysis and mitigation of derailment, assessment and commercial impact

4.5.7	ODE 1	122
4.5.8	ODE 2	122
4.5.9	ODE 3 slow loading	122
4.5.10	ODE 4 track irregularities	122
4.5.11	Summary of parameter studies	142
4.5.12	Bad case	144
4.5.13	Vehicle parameter limits	149
4.5.14	Vehicle configuration and observed load imbalances	161
4.5.15	Load imbalance criteria	165
4.5.16	Discussion and conclusions for vehicle parameter limits	161
4.6	References	164
5	Derailments due to sloshing	165
5.1	Background	165
5.1.1	Literature survey	165
5.2	CFD analysis	166
5.2.1	Description of the model of the fluid	166
5.2.2	Results	167
5.2.3	Damping	171
5.3	Equivalent mechanical model	172
5.4	Multi-body model of the tank vehicle	181
5.5	Results of the parametric analysis	188
5.5.1	Non-dimensional relation	188
5.5.2	Effect of the length of the intermediate straight	191
5.5.3	Effect of the curve radius	195
5.5.4	Effect of the fill level	197
5.5.5	Effect of the length of the counter-curve	198
5.6	Concluding remarks	200
5.6.1	Identified main affecting parameters	200
5.6.2	Estimation of commercial impact of preventive measures	201
5.7	References	201
6	Derailments due to wheel failures	202
6.1	Derailment scenarios	202
6.2	Studied wheel designs	209
6.3	Numerical simulations	209
6.3.1	Numerical models	209
6.3.2	Parametric studies	214
6.4	Results	215
6.4.1	Mechanical loading from wheel-rail contact	215
6.4.2	Thermomechanical loading from tread braking	220
6.4.3	Wheel web fatigue due to track brakes	230
6.4.4	Wheel web fatigue due to combined mechanical and thermomechanical loading	233
6.4.5	Cracks in wheel rim and web	237
6.5	Derailments caused by mechanical wheel tread cracking	243
6.5.1	Studied derailment scenarios	243
6.5.2	Influencing parameters	244
6.5.3	Prevention of wheel breaks caused by KCF	245
6.6	Concluding remarks	245
6.7	References	248
7	Derailments due to rail failures	250
7.1	Studied derailment scenarios	250

D-RAIL D3.2 Analysis and mitigation of derailment, assessment and commercial impact

7.2	Numerical simulations	250
7.2.1	Model for numerical analysis of dynamic interaction between wheel and rail	250
7.2.2	Model for numerical analysis of crack loading, risk of fracture and crack growth	254
7.2.3	Influence of main parameters – definition of a 'bad case scenario'	255
7.3	Operational conditions resulting in high risk of rail breaks	259
7.3.1	Nominal track conditions	259
7.3.2	Influence of hanging sleepers	260
7.3.3	Influence of lateral rail bending	262
7.4	Crack growth and pertinent inspection intervals	262
7.4.1	Influence of temperature	263
7.4.2	Influence of crack geometry	263
7.4.3	Load cycles for crack growth prediction	264
7.5	Wöhler curve based prediction	268
7.6	Validation of predictions	268
7.7	Other rail break mechanisms	270
7.8	Concluding remarks	270
7.8.1	Identified main affecting parameters	270
7.8.2	Estimation of commercial impact of preventive measures	271
7.9	References	271
8	Conclusions	273
8.1	Derailment due to flange climbing in line operations	273
8.1.1	Limits to lateral load imbalances	273
8.1.2	Logic suspension variation	274
8.1.3	Suspension failure and faults	275
8.1.4	Isolated track defects	275
8.2	Derailments in switches & crossings	275
8.2.1	The most influential parameters	276
8.2.2	Bad vehicle-turnout cases	276
8.2.3	Vehicle parameter limits	277
8.2.4	Implementation strategy	278
8.3	Derailments due to sloshing	279
8.4	Derailments due to wheel failures	280
8.4.1	Identified main affecting parameters	281
8.4.2	Estimation of commercial impact of preventive measures	282
8.5	Derailments due to rail failures	282
8.5.1	Identified main affecting parameters	282
8.5.2	Estimation of commercial impact of preventive measures	285
Appendices		284
Common model for WP3.2		284
Vehicle Parameters of the Benchmark V25 Box Wagon		284
Track Parameters		287
Dynamic Simulation Environment		287
Results table for influence of vehicle parameters on derailment resistance		291
Comparison of EN 14363 and GSN/MT 2141 – with respect to resistance to derailment, in the context of D-RAIL simulation cases		295
Overview of the methods		295
Equivalents between the standards		296
Differences between the equivalent methods		297

RESULTS



Main European derailment causes:

- Poor track geometry
 - excessive track width
 - excessive track twist
 - track height/cant failure
- Poor vehicle conditions
 - skew loading
 - spring & suspension failure
- Failures
 - axle ruptures
 - wheel failure
 - rail failures

Major causes and key parameters!

Well-founded operational limits!

Monitor the right things at the right levels



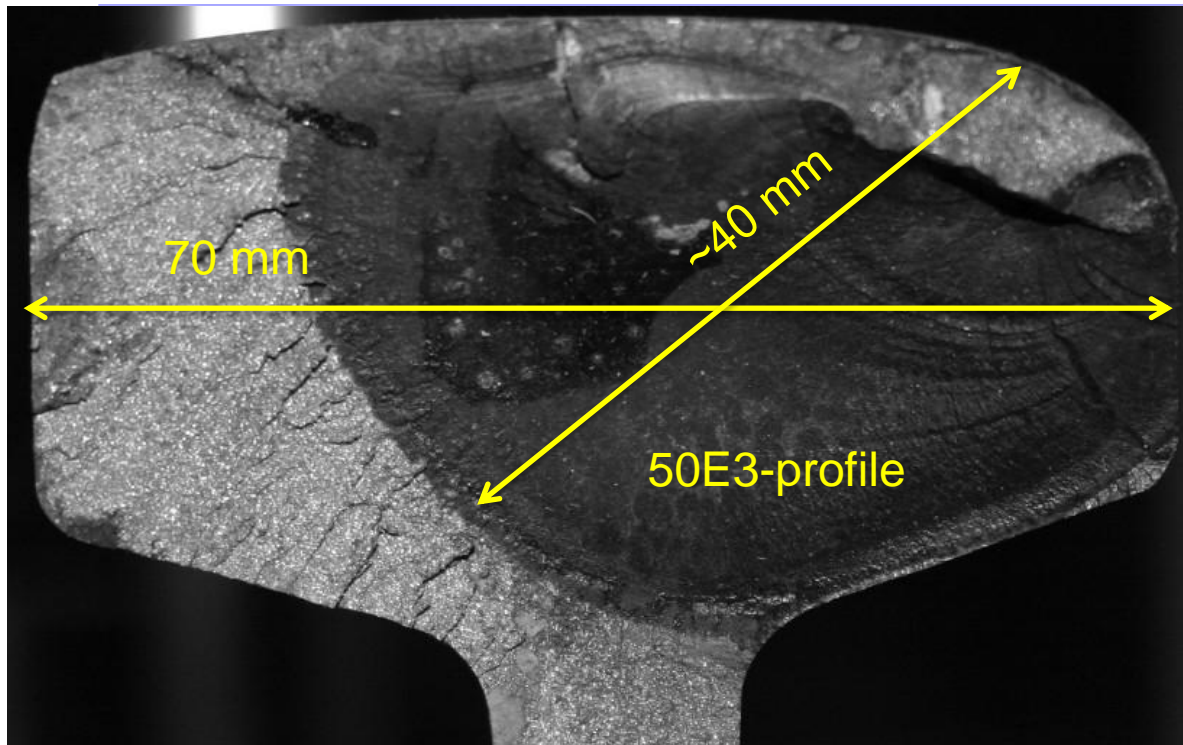
Implementable results from WP3 (as compiled in D7.1)

- 37 potential modifications ranked (low, moderate, high) in terms of cost of implementation
- 29 means of influencing the risk of derailments

Examples of “not-too-high” hanging fruit

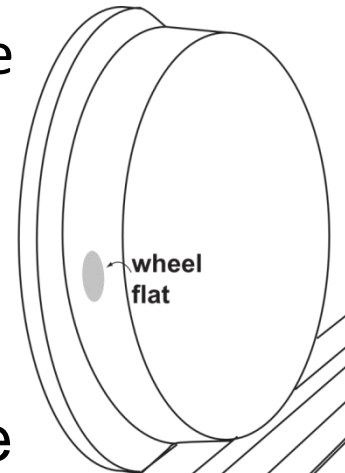
- Improved regulations (elaborated in the UIC-led HRMS project)
- Integrated prediction of crack growth in wheel load sensors to aid planning and maintenance
- Improved design / approval guidelines for wheels and running gear
- Improved and harmonized reporting guidelines and follow-up routines based on key parameters

RESULTS – RAIL BREAKS

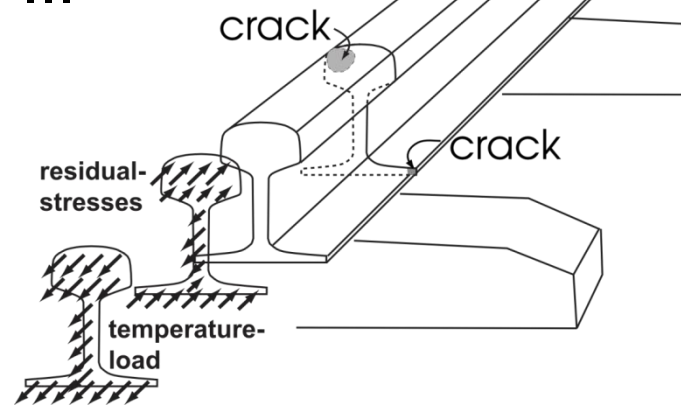


Influencing parameters

impact load
temperature
vehicle
speed
track
sleepers
impact type



...

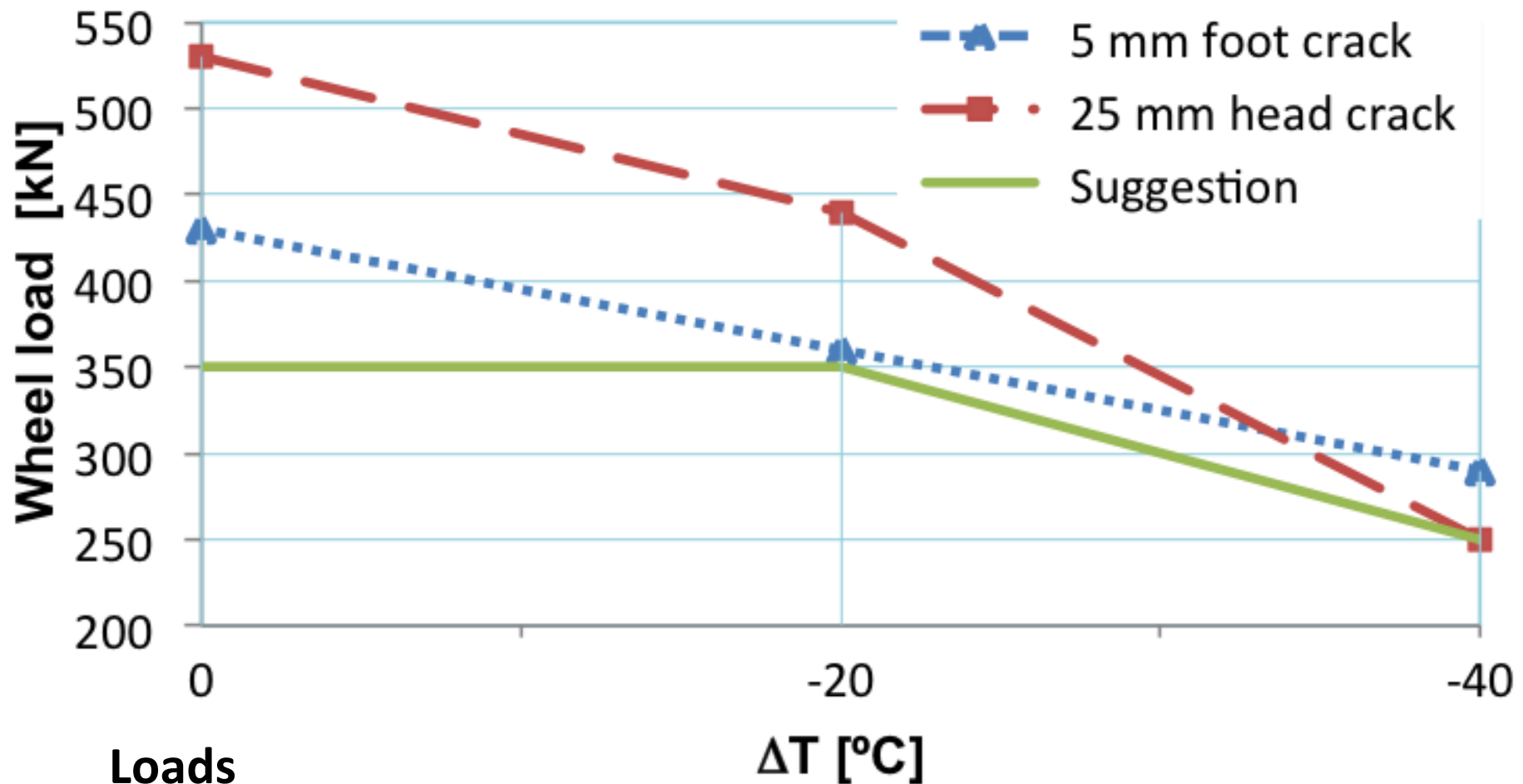


~10 mm

RESULTS – ALARM LIMITS FOR RAIL BREAKS



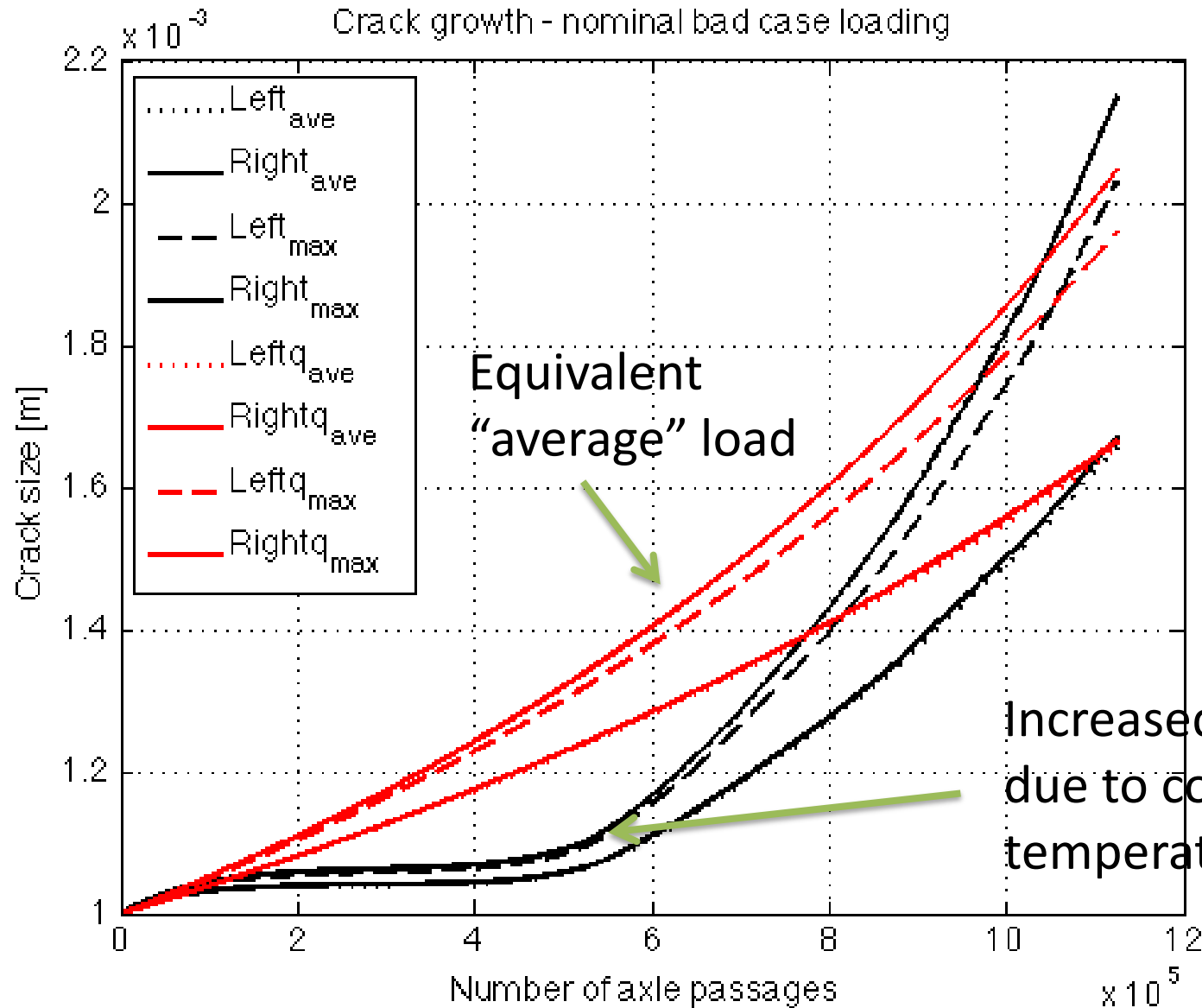
Impact load limits *versus* rail crack size



Loads

- bending from impacting wheel flat
- tension from thermal loading

RAIL BREAKS – CRACK GROWTH



EXAMPLE:
Foot crack – nominal “bad case” scenario
Measured load magnitudes (average or peak for each wheel)

Some key parameters

- wheel/rail friction
- suspension characteristics
- track twist
- side bearer vertical bump stop clearances
- geometry of isolated track defects

Some current derailment related regulations

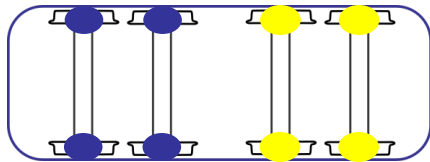
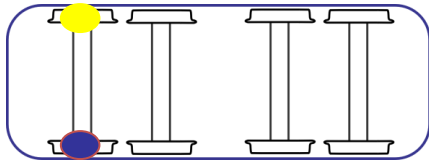
- GM/RT 2141 (tentatively too severe)
- EN 14363 (tentatively too lenient)

RESULTS – ALARM LIMITS FOR RAIL CLIMB



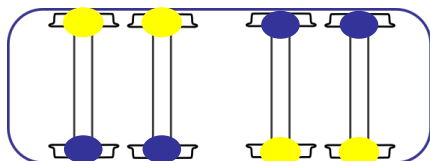
Flange climbing

- axle
- longitudinal

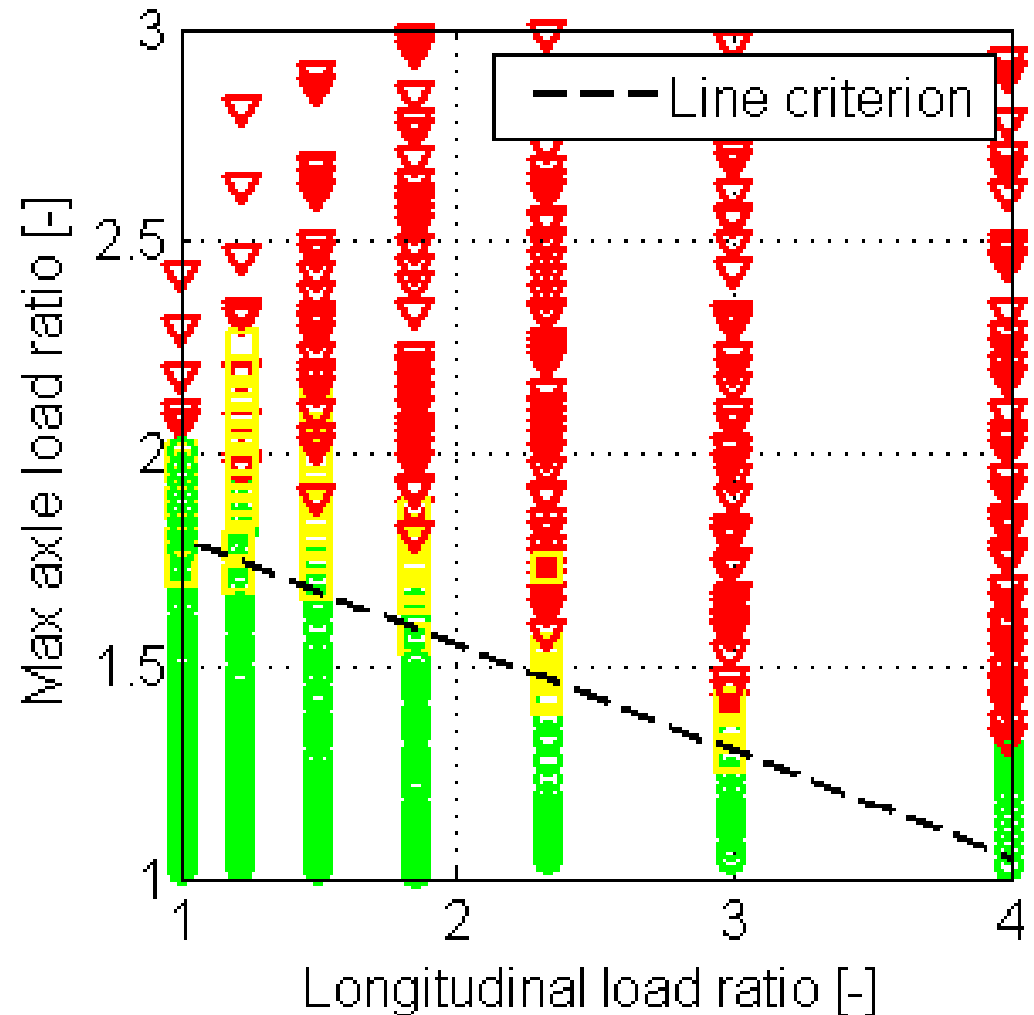


Chassis twist (tare)

- diagonal



- 1:1.7 – stop
- 1:1.3 – maintenance

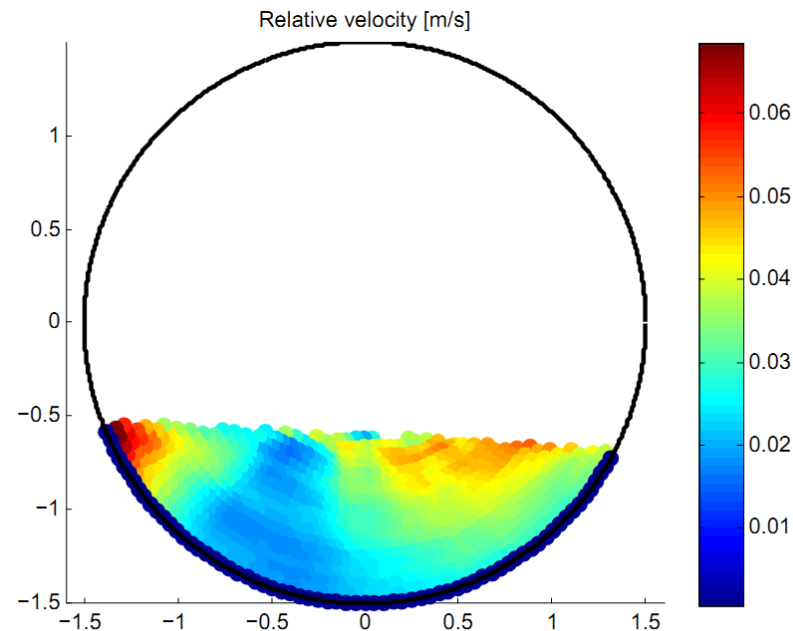


RESULTS – SLOSHING

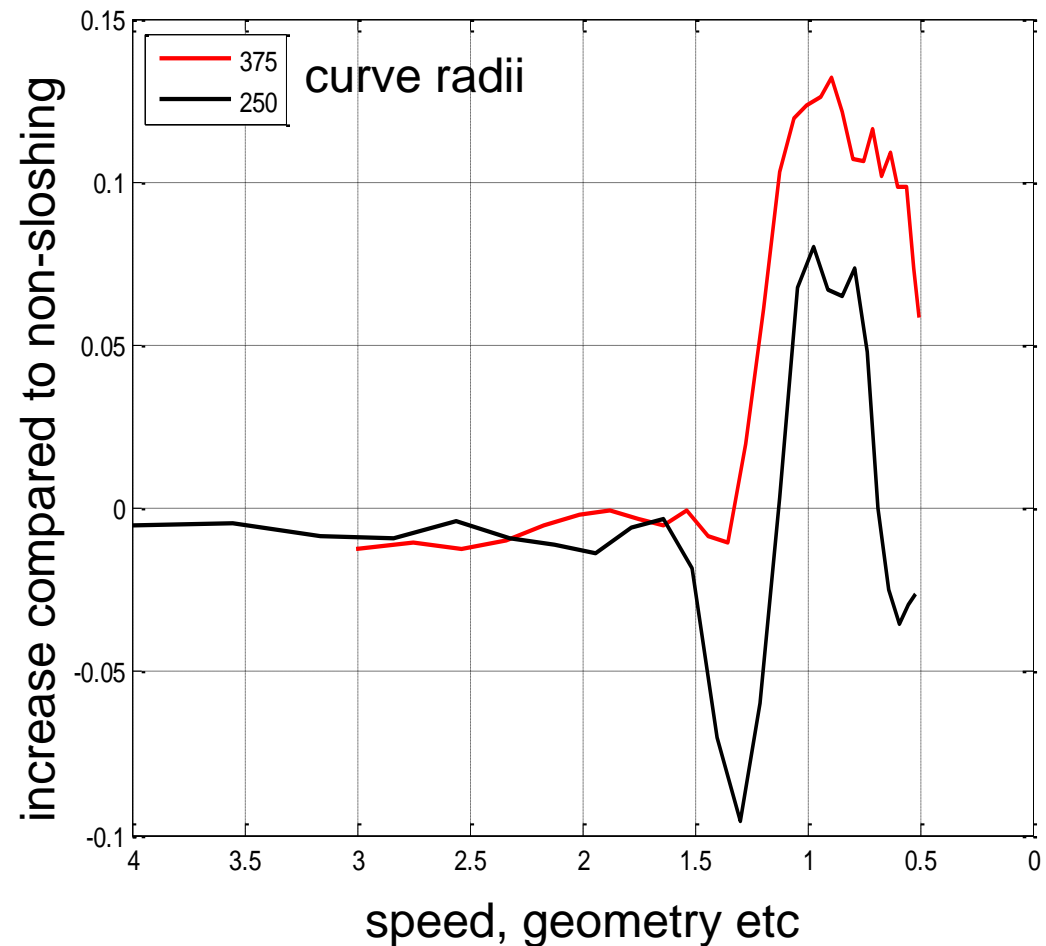


Influence of sloshing

- increases risk of rollover (not flange climbing)
- S-curves and ~50% fill levels are worst cases
- <20% increase



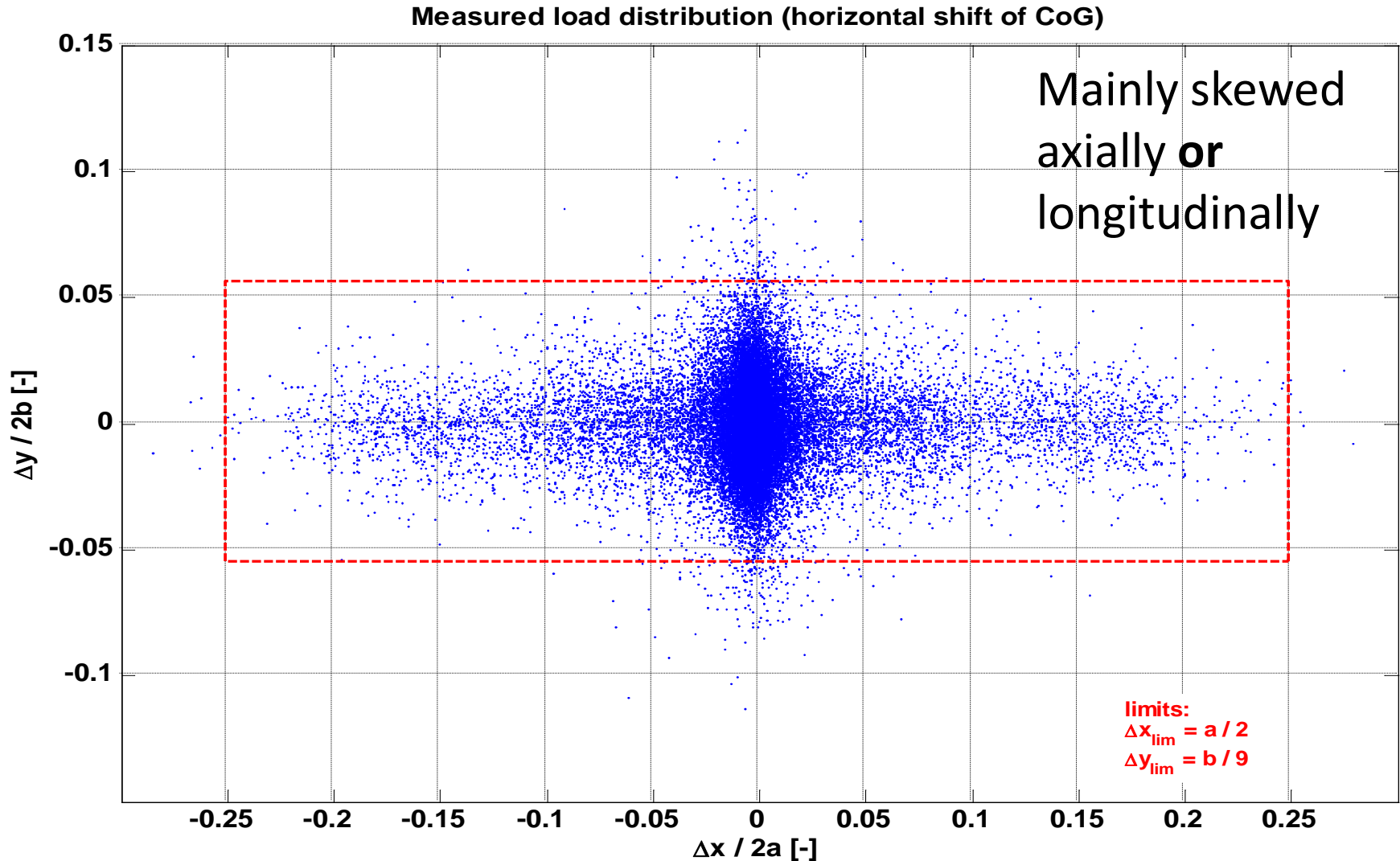
(a) $\chi=25\%$



RESULTS – CURRENT SITUATION



Why don't we derail today?



Some key findings for web cracks

- Very slow growth in depth direction.
- For the crack to grow in the depth direction, it must be very extended circumferentially

Fatigue sensitivity

- Increase of vertical loading
 - **straight track:** minor increase of fatigue
 - **curving and negotiation of points and crossings:** substantial increase in fatigue stresses.
- Low-stress wheels
 - better for thermal load resistance
 - more sensitive to mechanical fatigue especially due to wheel flats away from the rolling circle

WP3 – Final remark

- The Guideline D3.3 is extensively backed by background details in D3.2
- Recommendations and suggested limits are scientifically based. This means:
 - Background assumptions and analyses are documented
 - The analyses can be extended to new and/or altered operational scenarios
 - The consequence of any deviations to recommendations can be quantified

This promotes a sound technical discussion to obtain consensus

- The working group included representatives from across Europe (and USA), which aids in obtaining a broad view

THE END



Thank you for your kind attention

