

# haulers and haul roads

*joint performance  
benchmarking for 2015*

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**JPi mine equipment**  
& University of Alberta



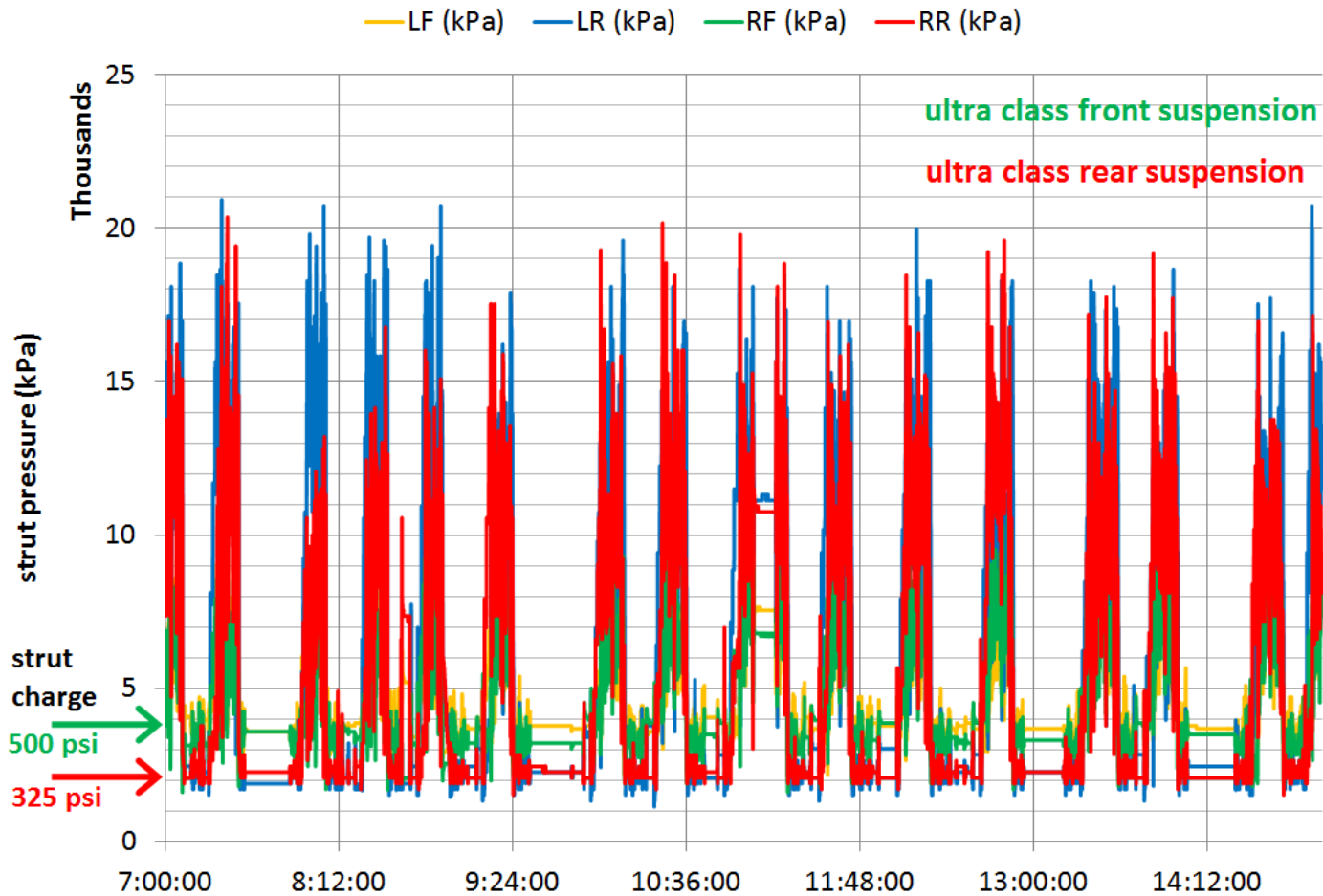
**mine equipment**  
performance analysis  
engineering services  
short courses



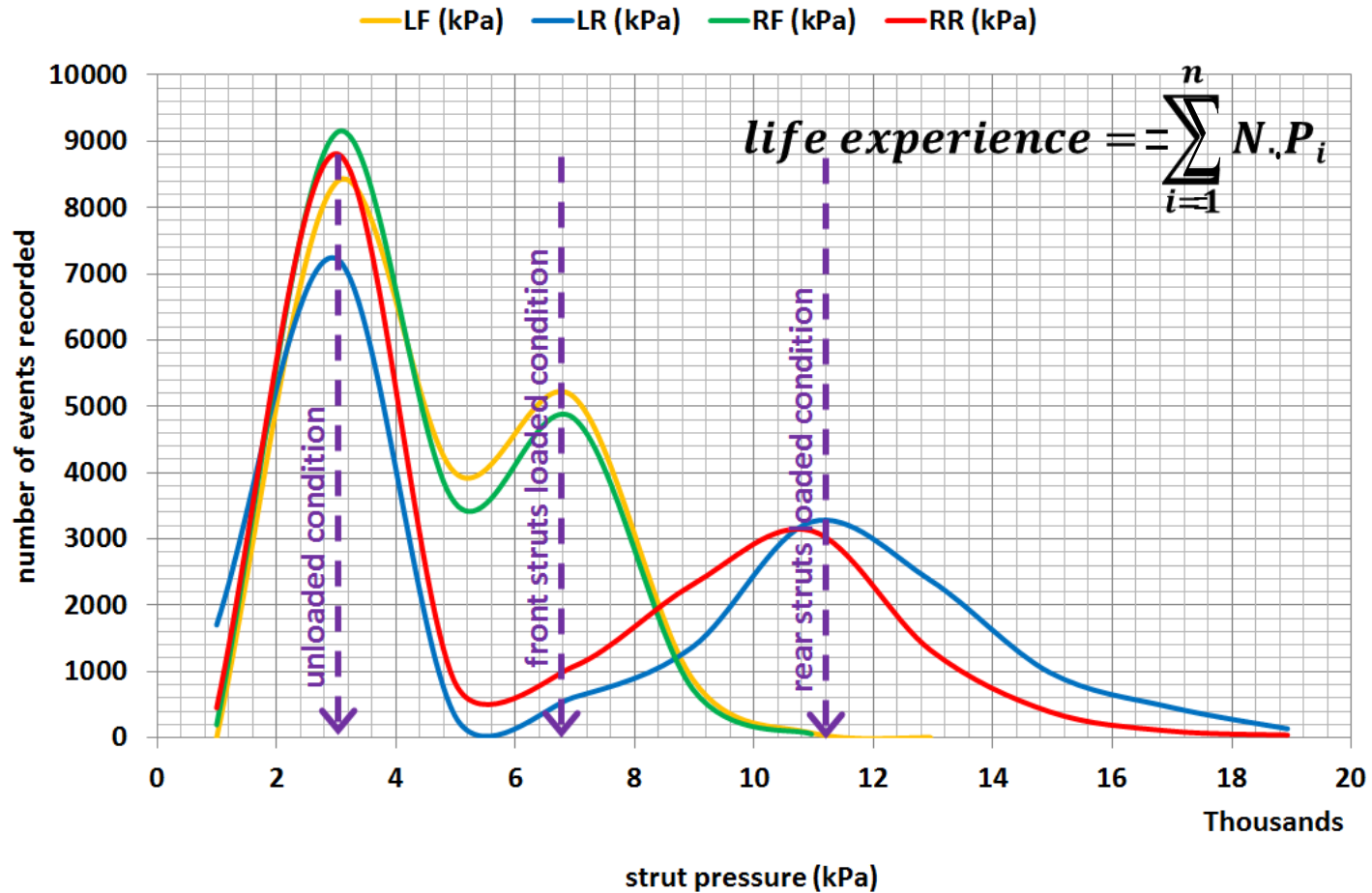
# data we already have today ...

- Suspension data holds much more than an onboard system, VIMS or Komtrax, reveals
- **Pressures to Forces to Deformations** are easy step by step calculations that reveal
  - Suspension and structural frame performance
  - Tire performance
  - Running surface performance
  - Maintenance requirements
- Instant indicators lead to **life performance evals**
- **For application today**

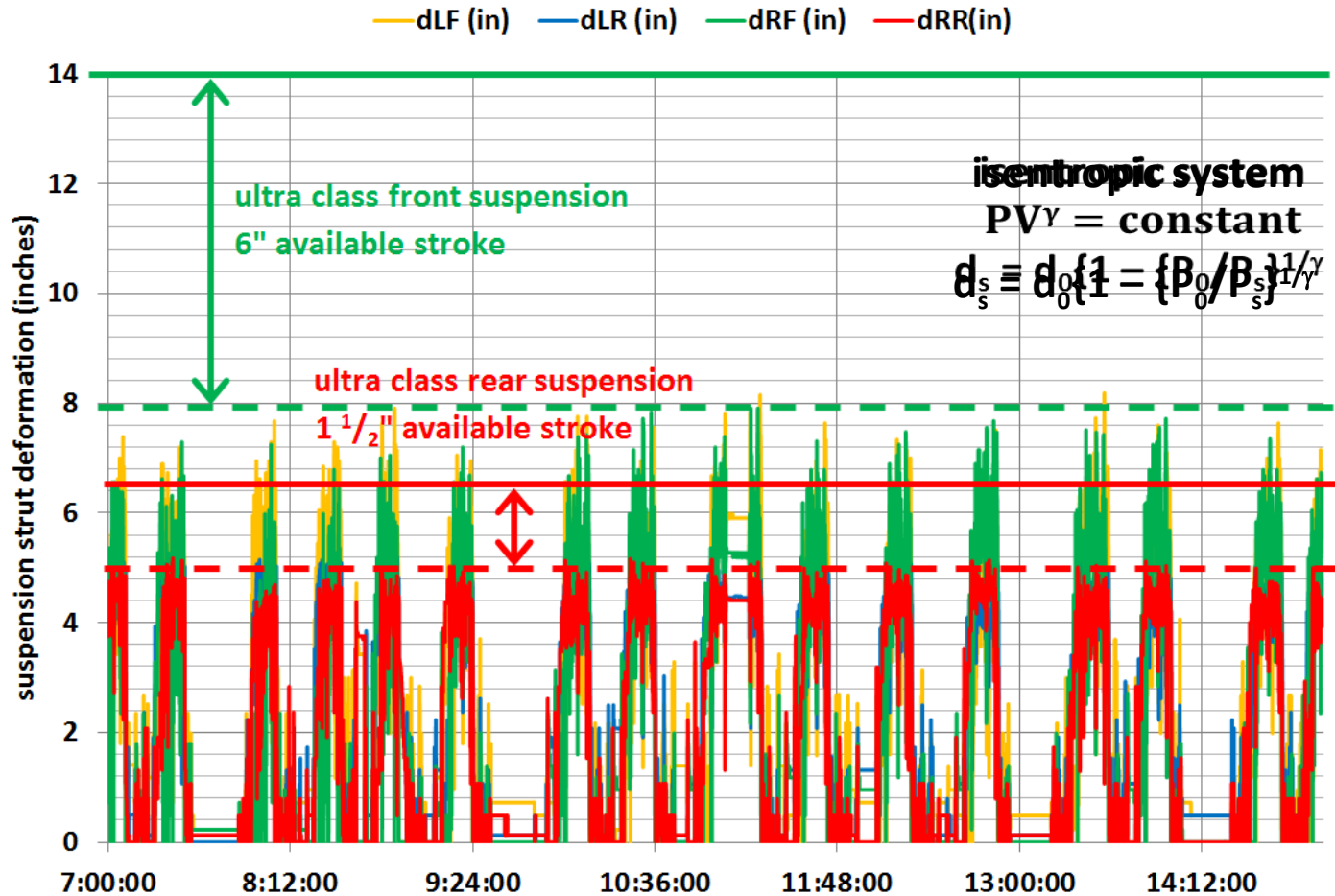
# Available on-board strut pressure data



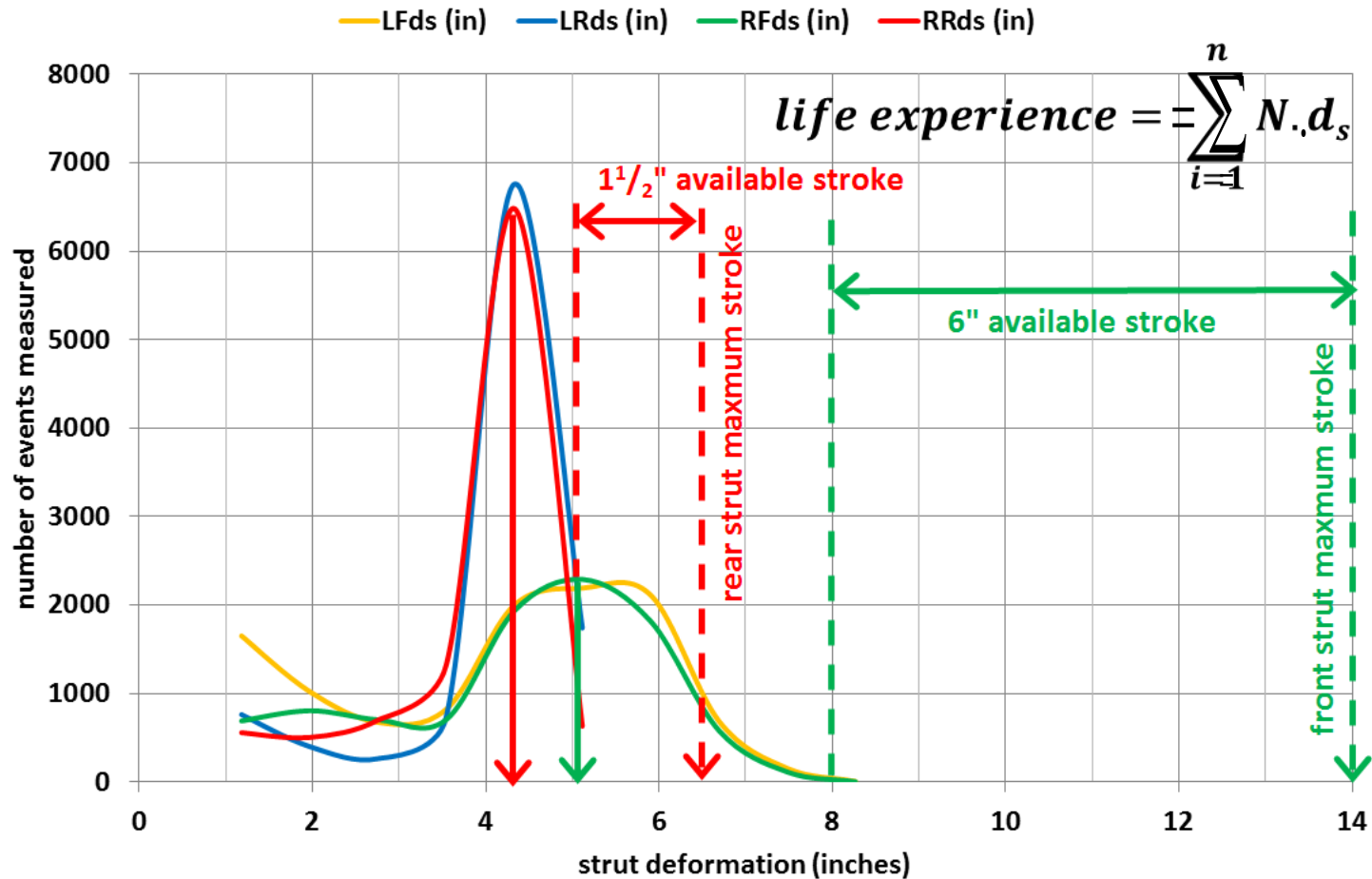
# life experience = area under curve



# strut (suspension) performance



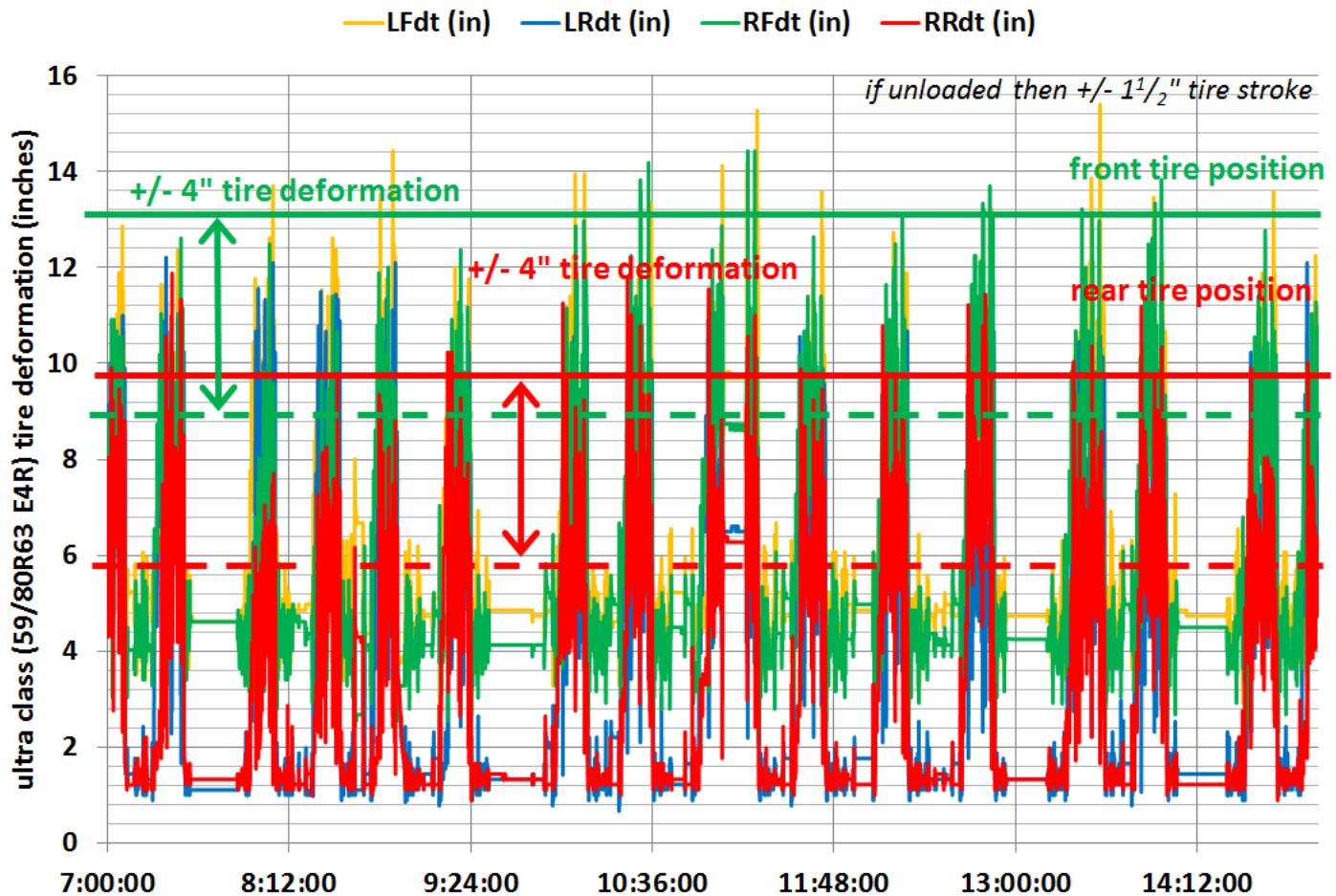
# strut (suspension) life performance



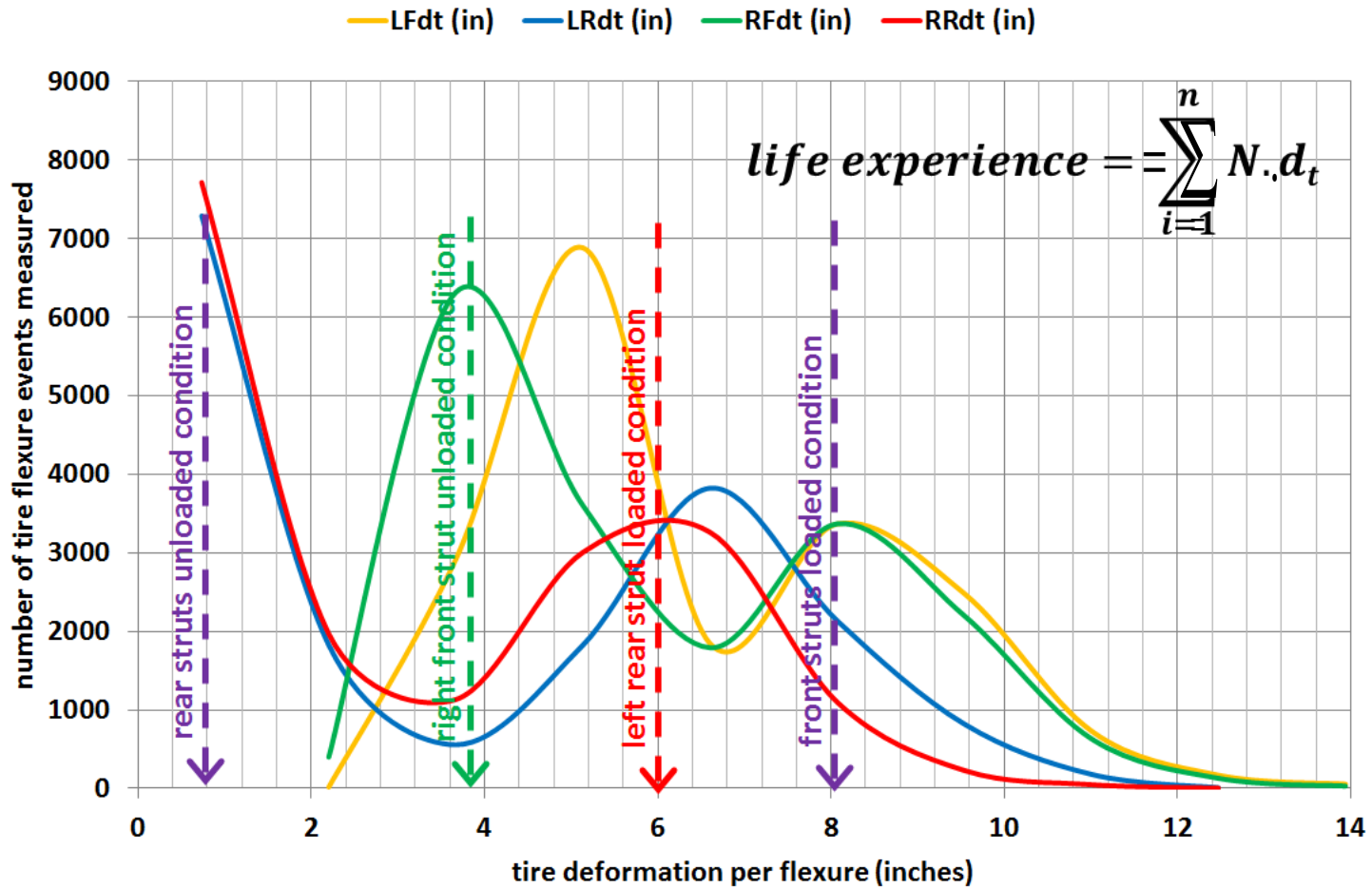
# tire flexure by position

elastic system

$$d_t \ddot{a}_t = kF$$
$$k = 3850 \text{ kN/m}$$
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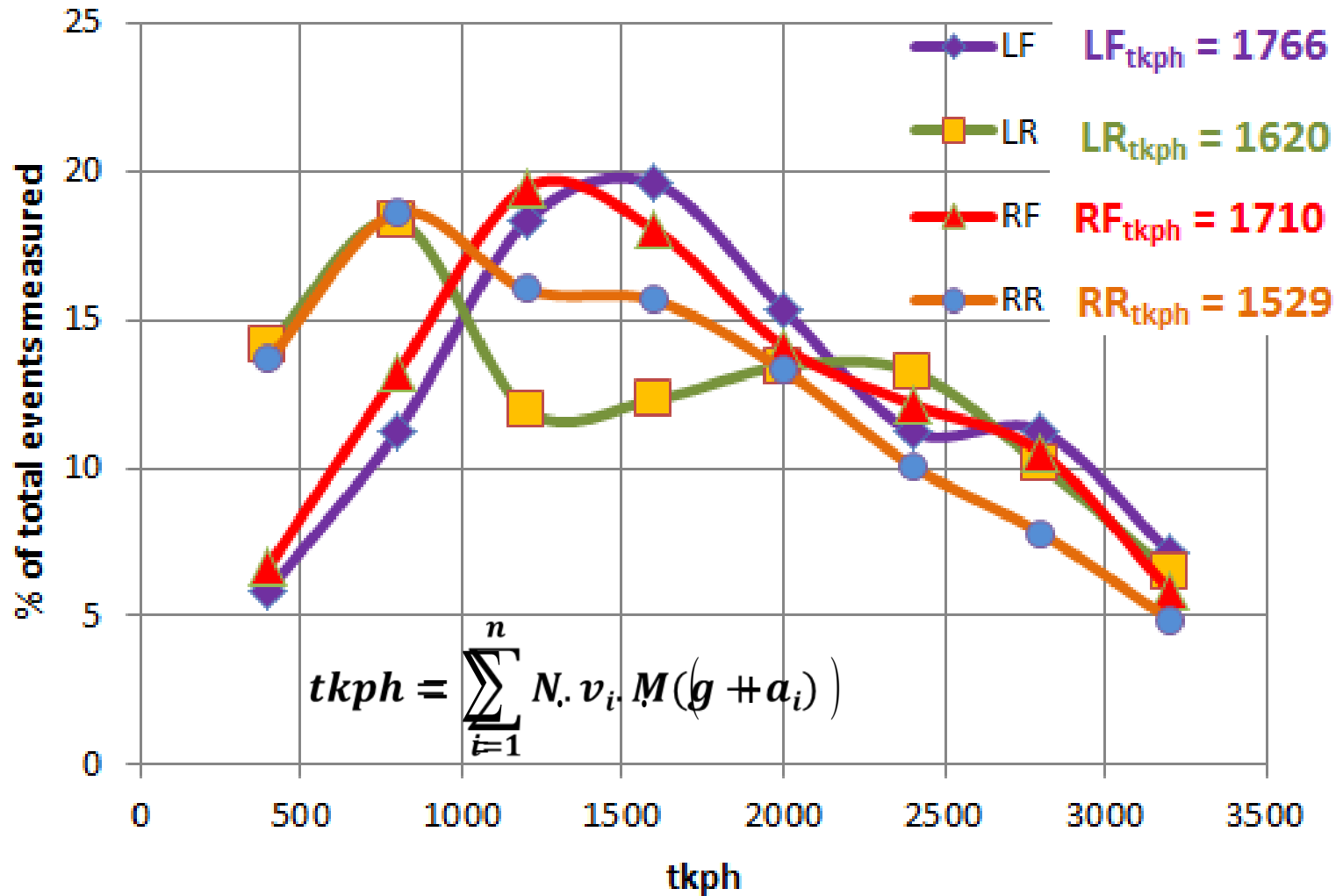


# tire cyclic flexure distribution

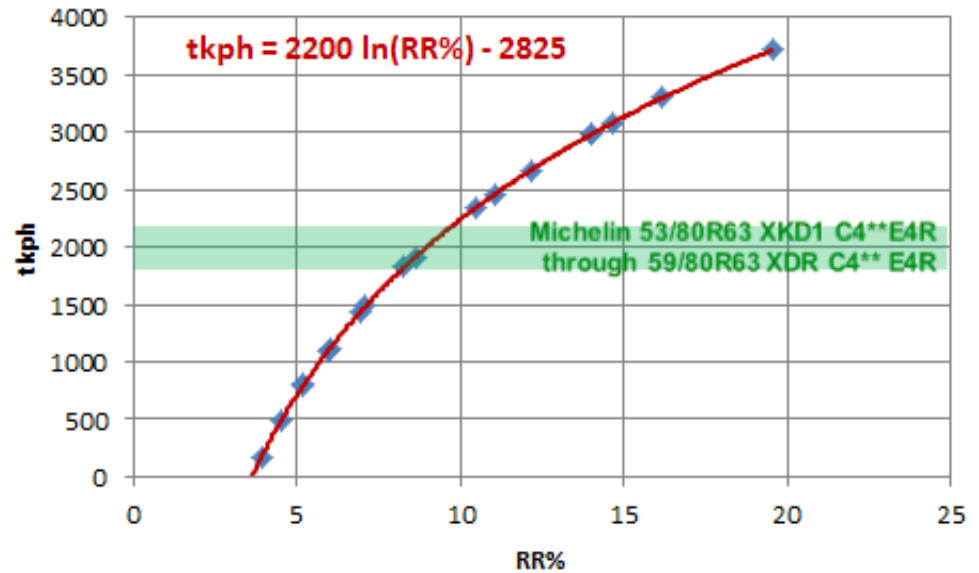
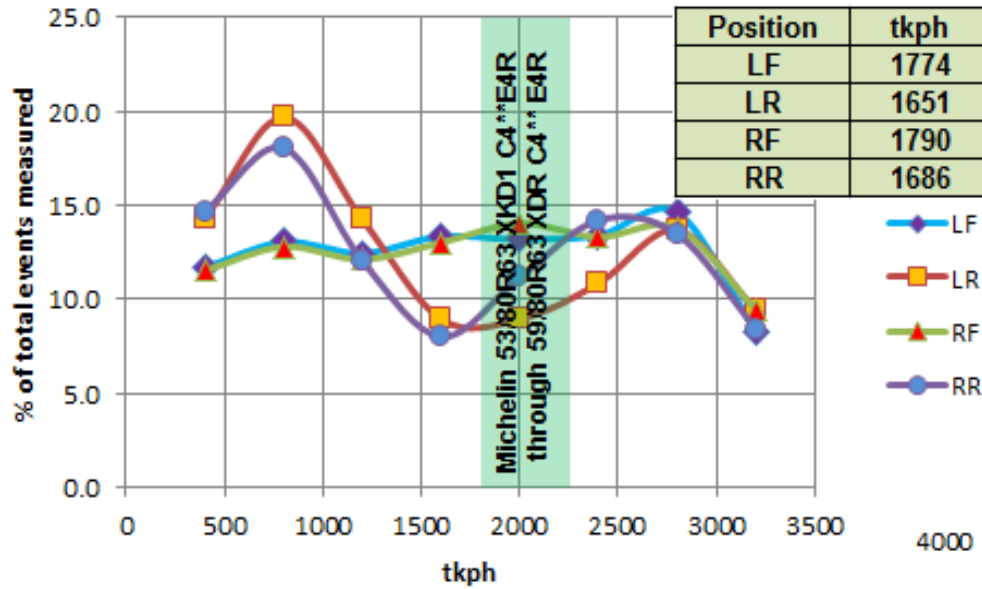




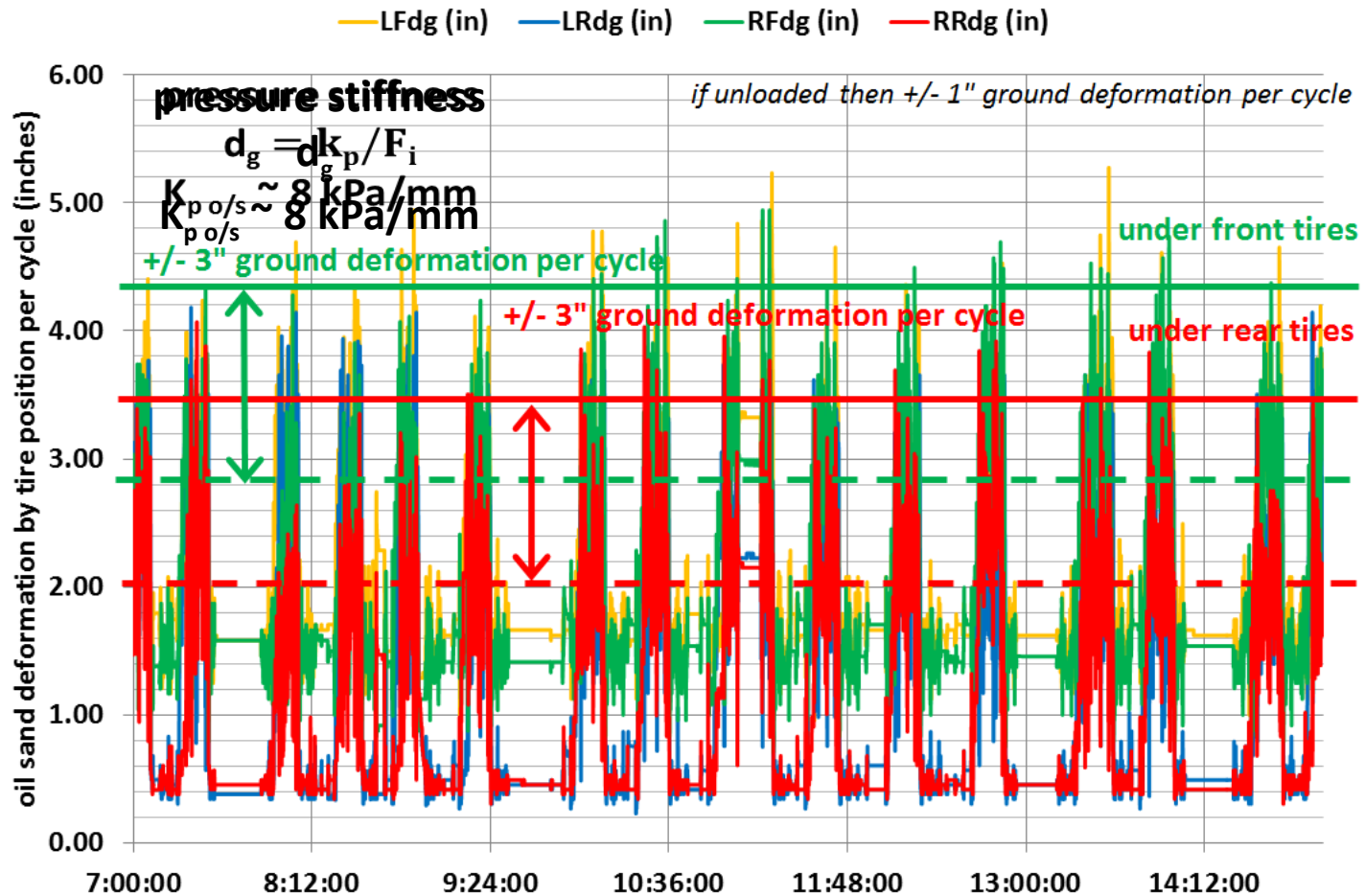
# real-time tkph (incl. all motions)



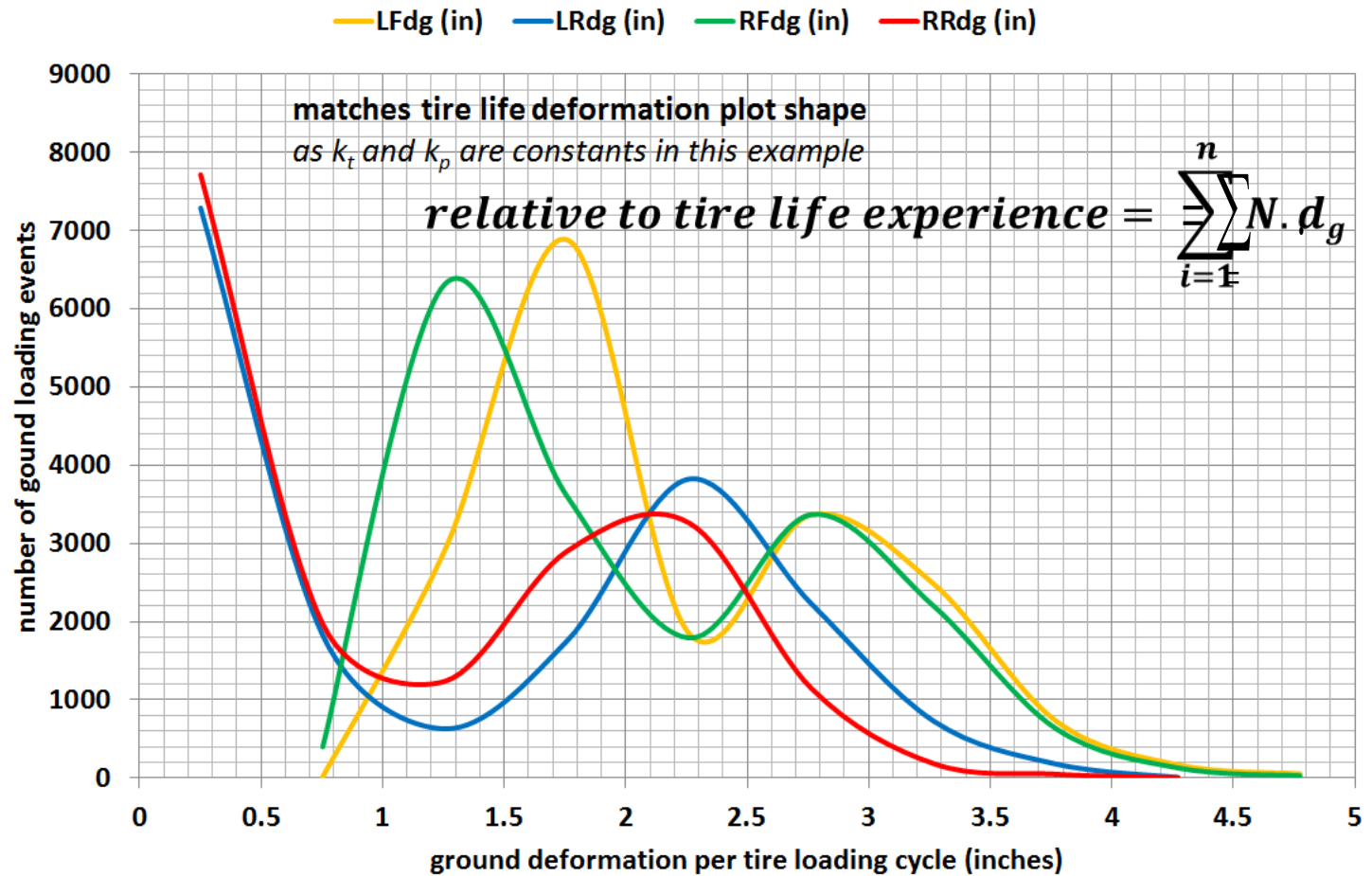
# tire tkph versus RR impact



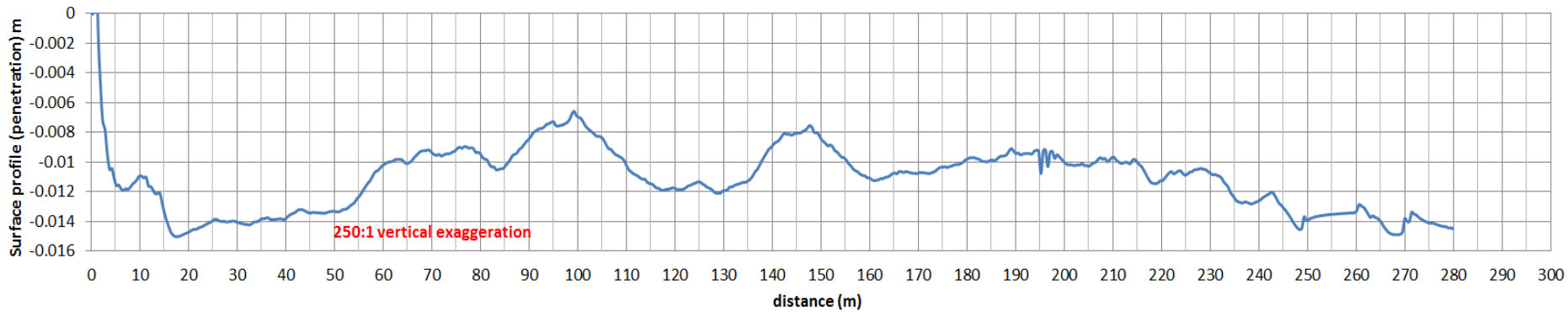
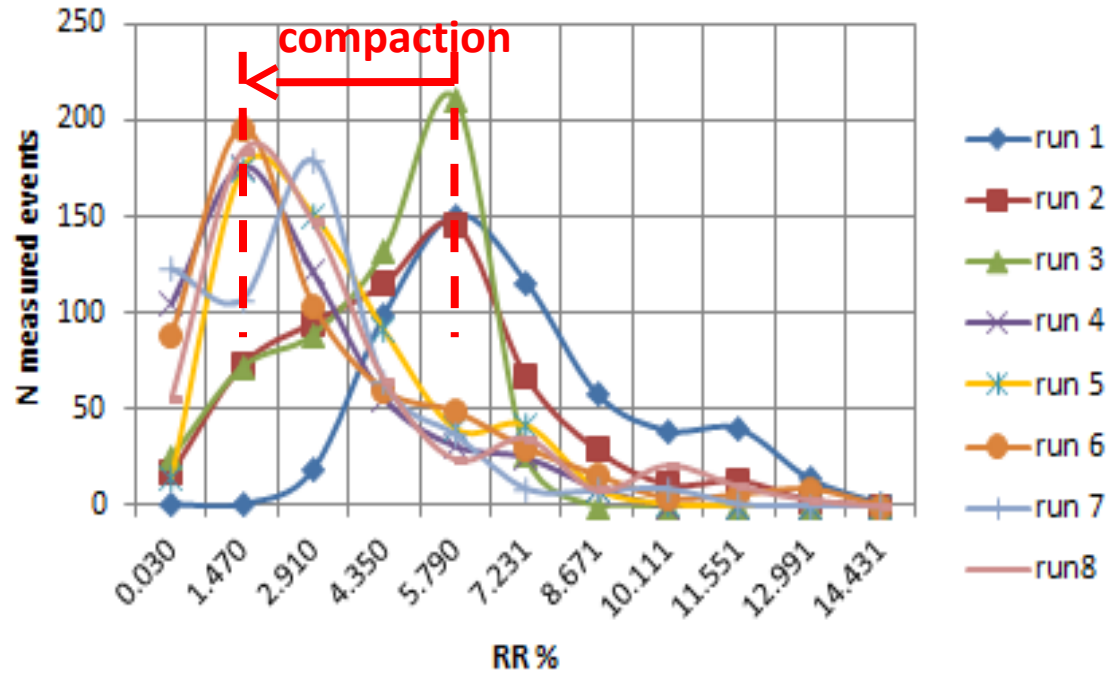
# oil sand ground response



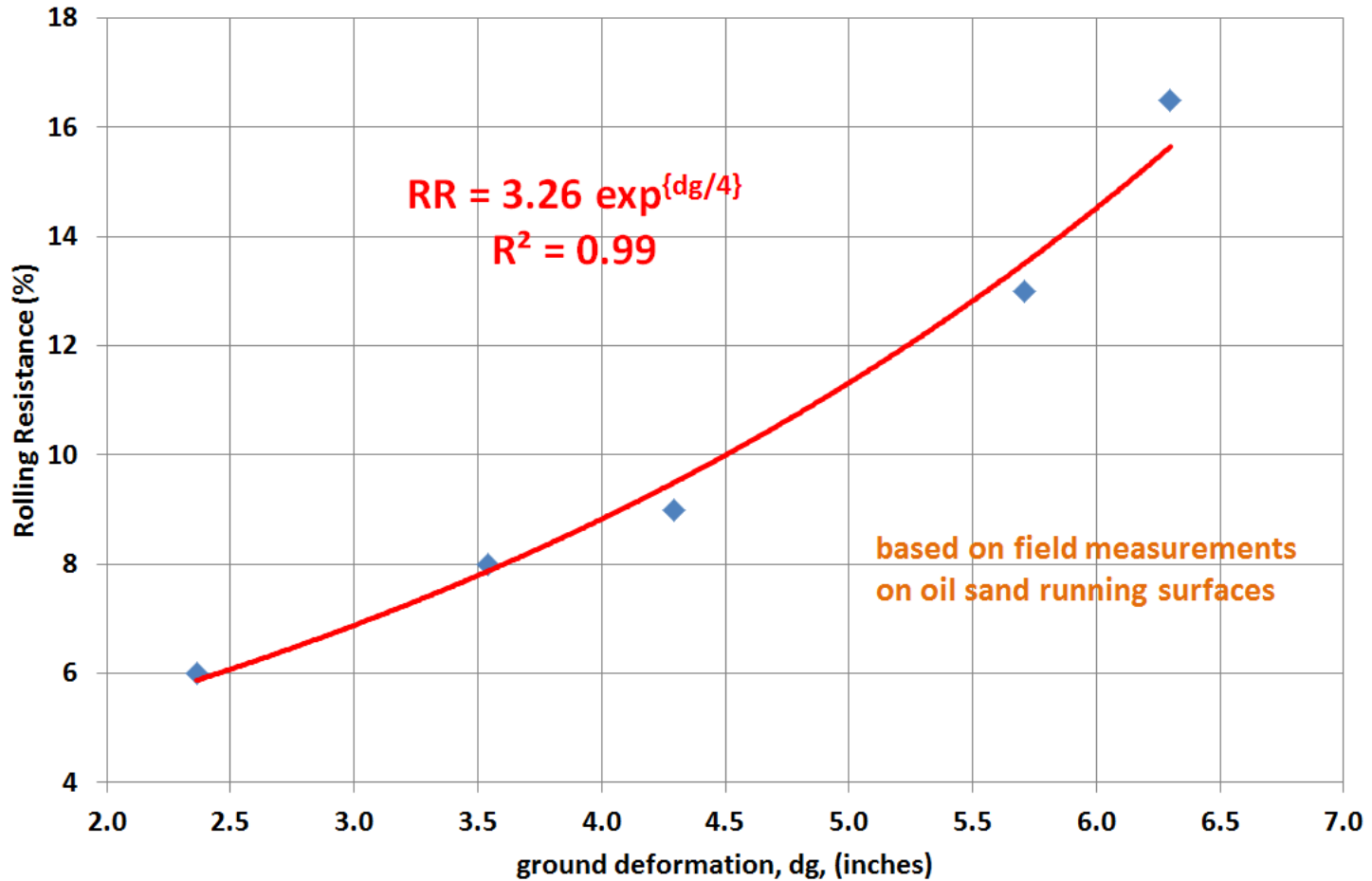
# 'beneath tire' oil sand response



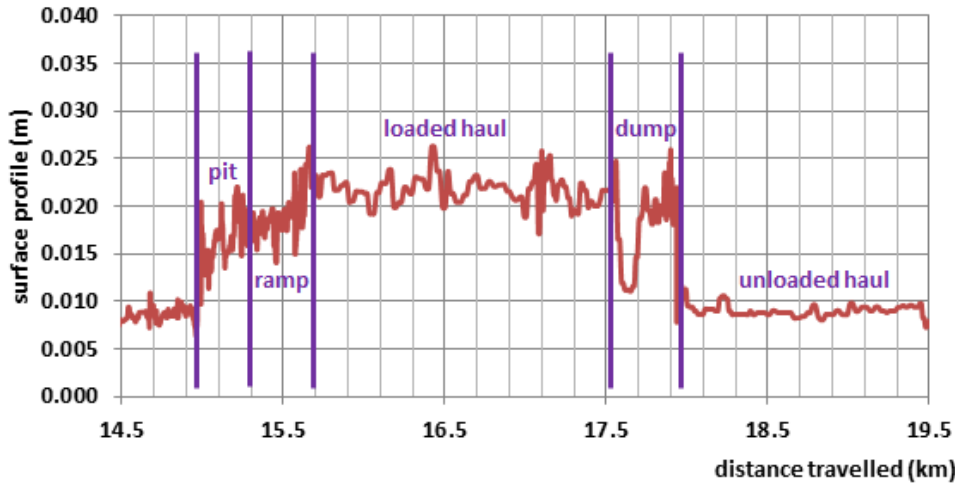
# haul road RR performance test



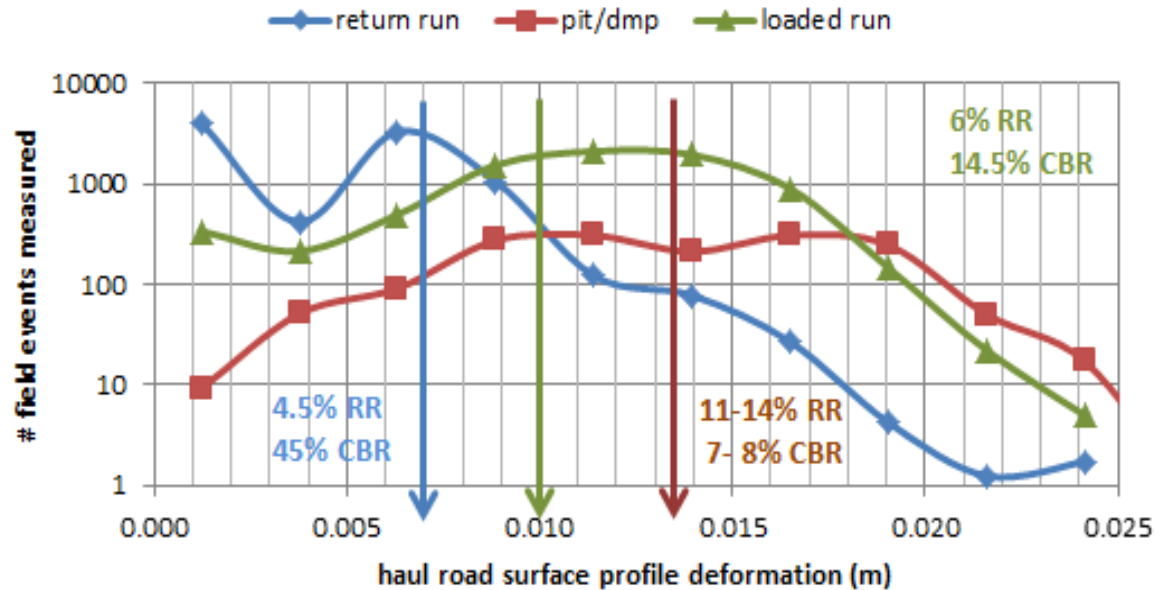
# RR - $d_g$ calibration (*oil sand haul*)



# haul surface duty cycle performance

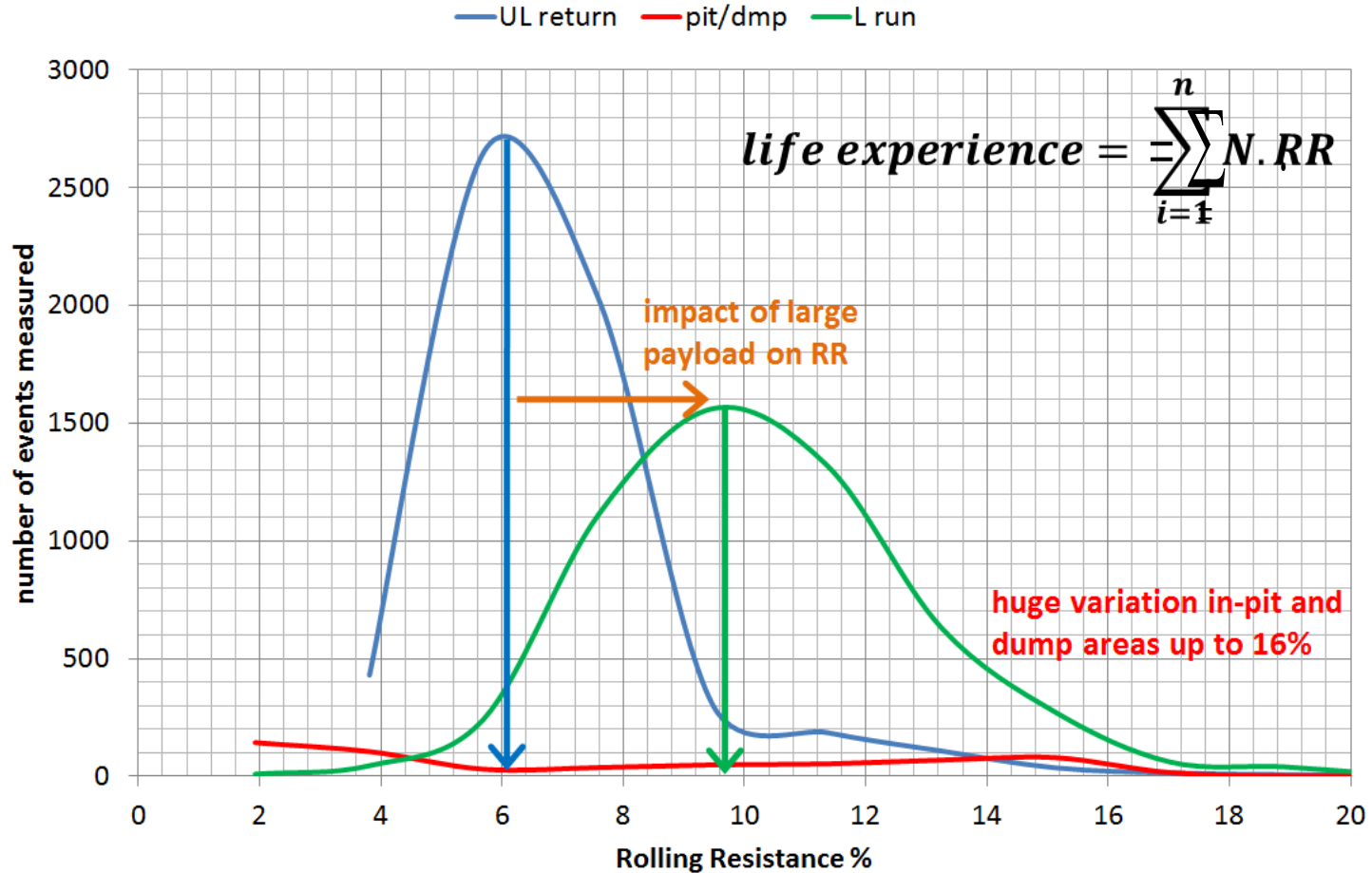


a single duty cycle



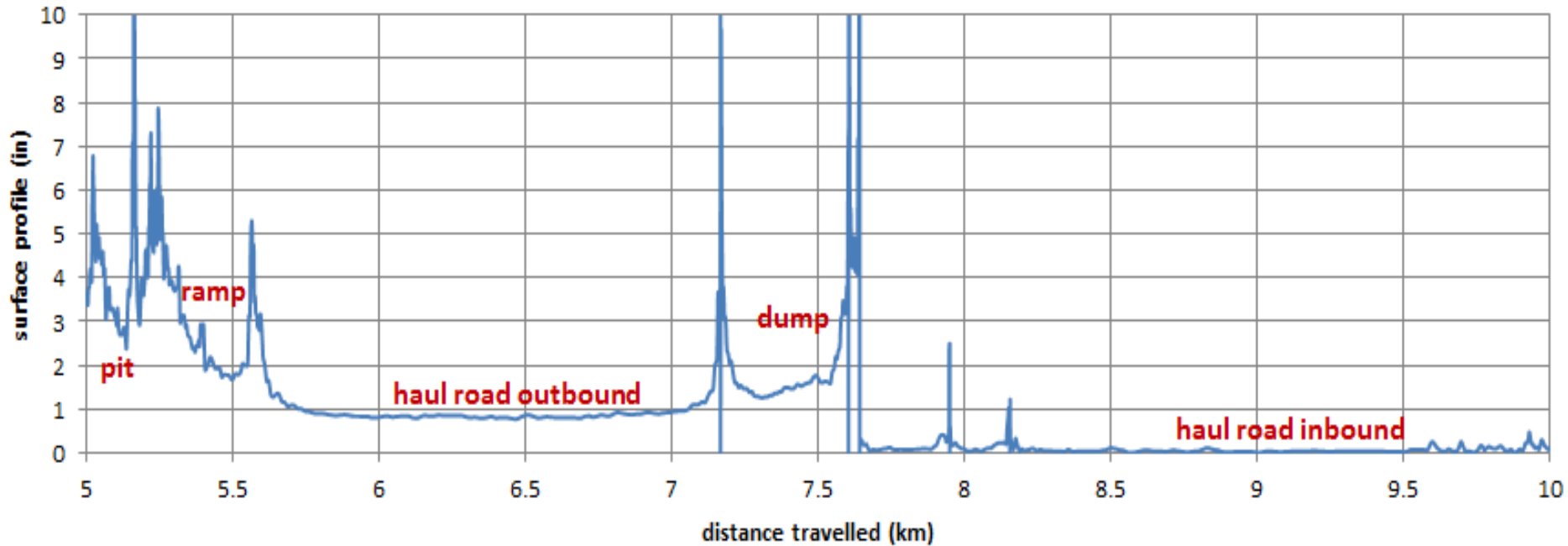
a week of duty cycles

# oil sand ultra-class running surface RR

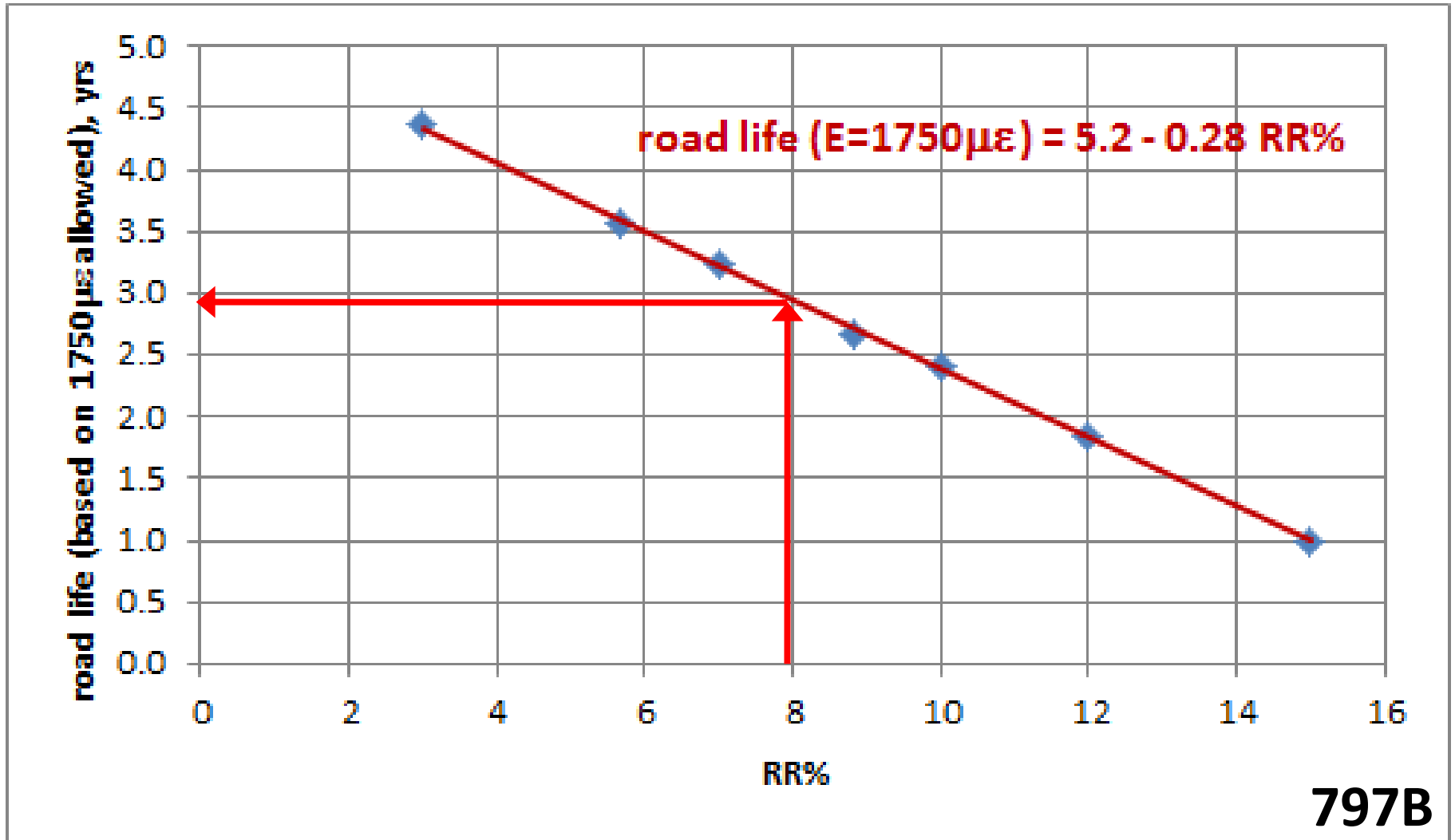




# typical ultra-class haul road profile



# 797B haul road surface life estimate

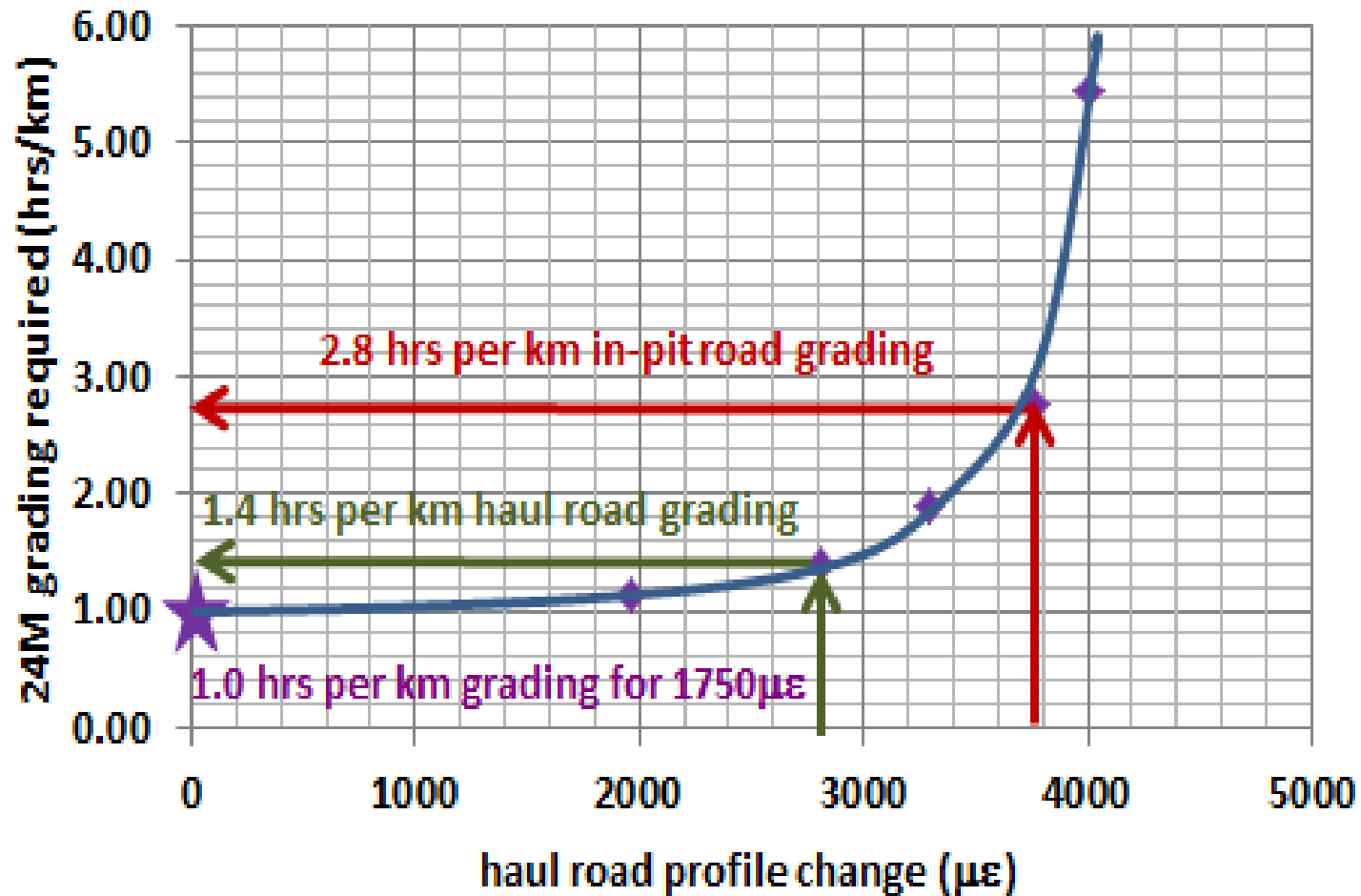


**797B**

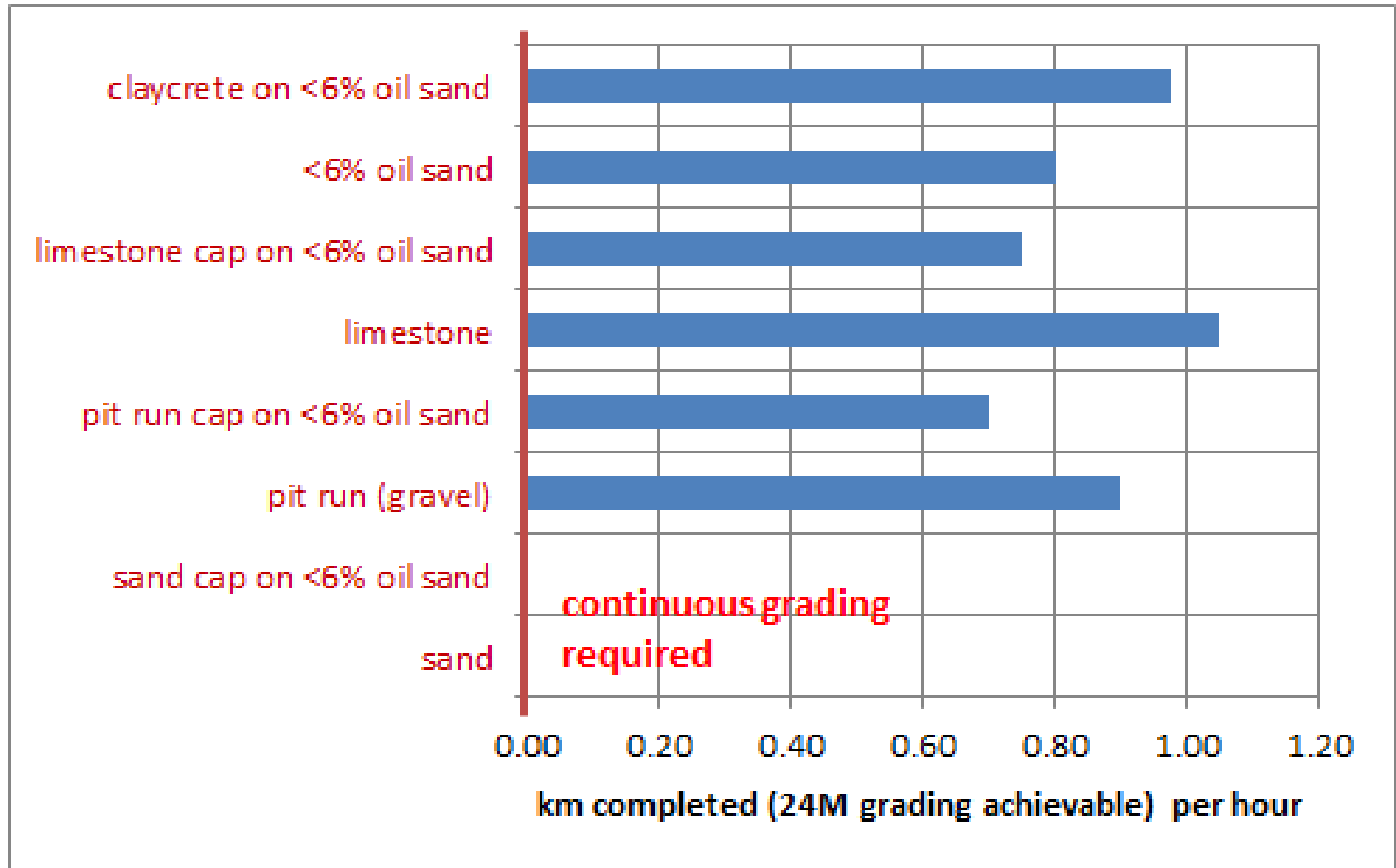
# typical grader operations data

surface	distance (km)	op time	kph	TR est	RR est	profile (in)
shovel ramp	1.33	4.16	0.32	13.00	7.50	5.06
service road	2.89	7.84	0.37	11.27	8.27	5.45
upper bench roads	6.47	11.27	0.57	7.23	7.23	4.91
haul road to dump	3.69	10.82	0.34	12.19	9.19	5.87
upper bench roads	4.07	5.50	0.74	5.60	5.60	3.89
haul road to ramp	2.15	2.71	0.79	5.23	5.23	3.61
pit ramp	0.77	2.00	0.39	10.75	6.75	4.64
pit zone	0.32	0.70	0.46	10.11	10.11	6.25
sand st to shovel ramp	0.29	0.80	0.37	12.58	9.58	6.04
main haul roads	7.90	10.12	0.78	5.90	5.90	4.10
upper bench roads	6.07	11.52	0.53	8.75	7.75	5.19
haul roads	4.99	5.29	0.94	4.88	5.88	4.09

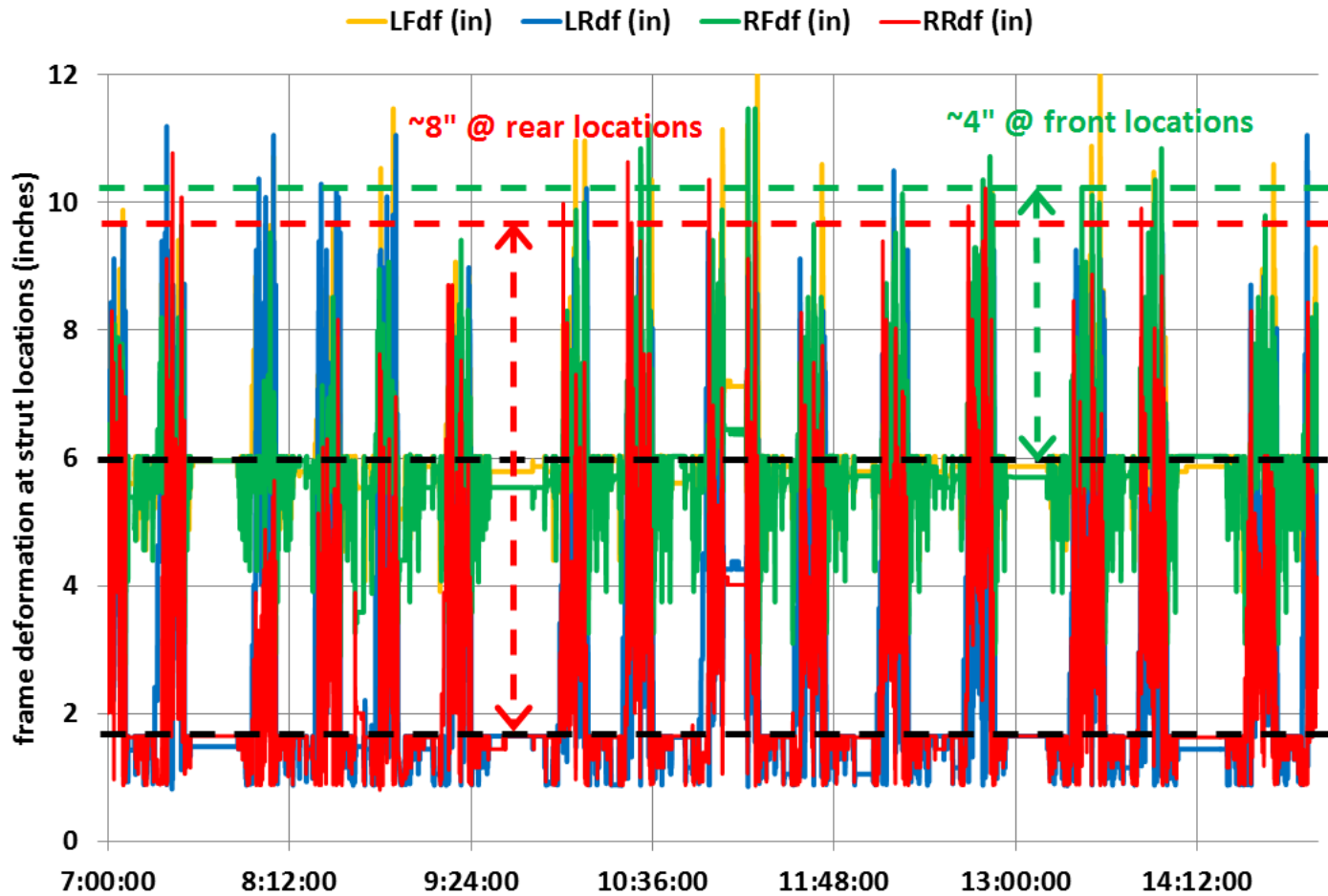
# 24M grader requirements



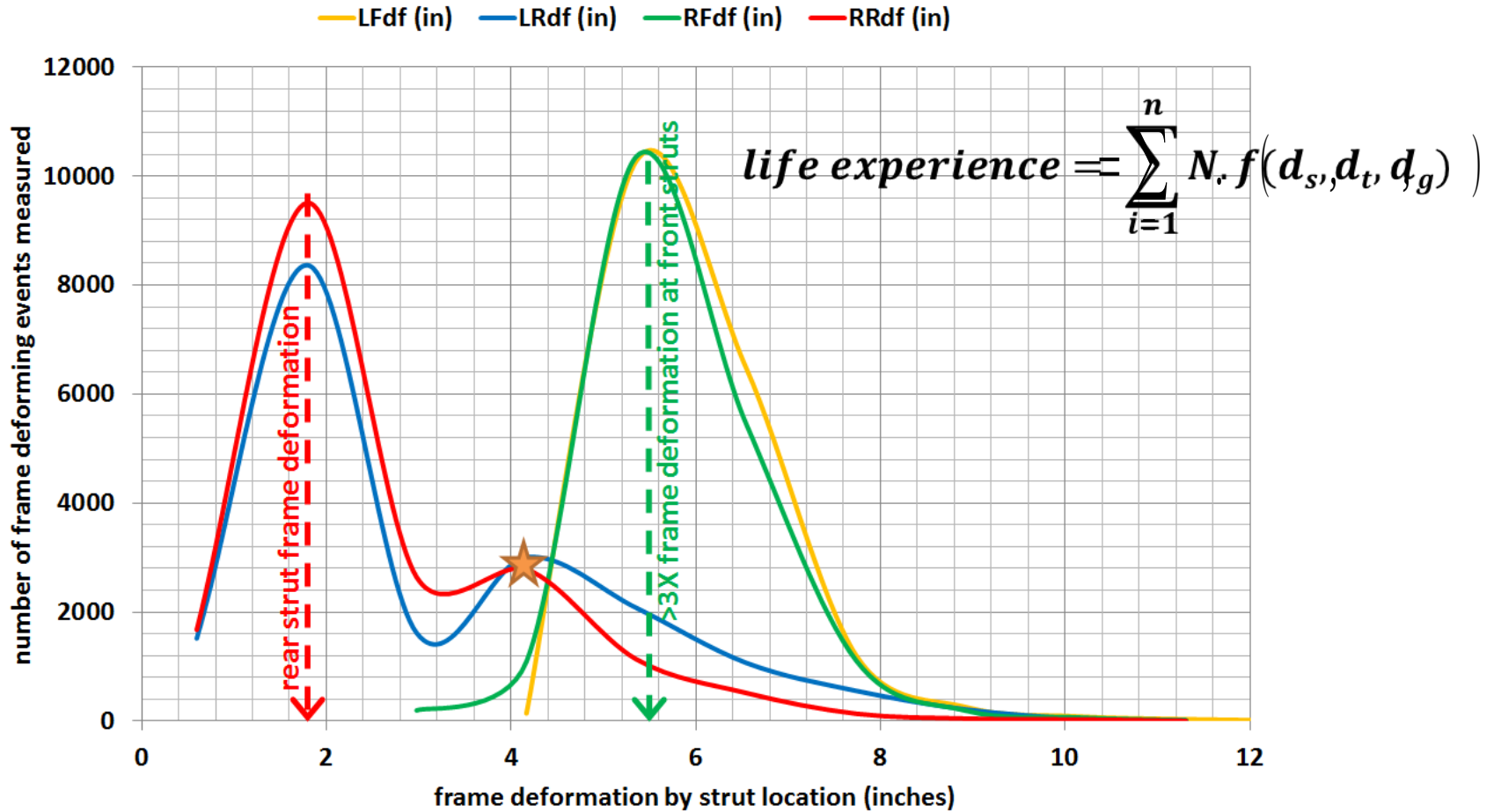
# grading requirements by surface



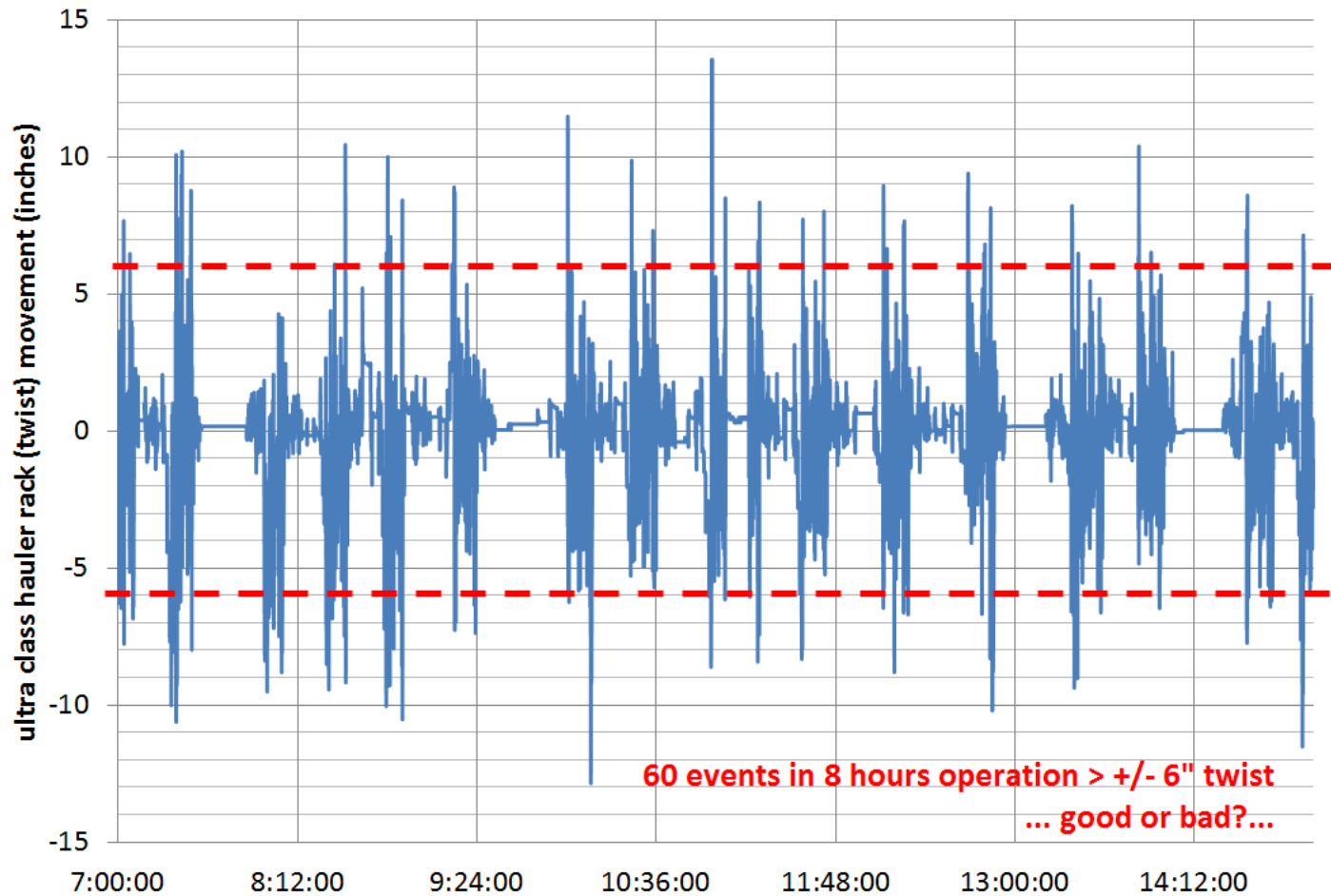
# relative movement at the frame



# life deform. at strut-frame positions

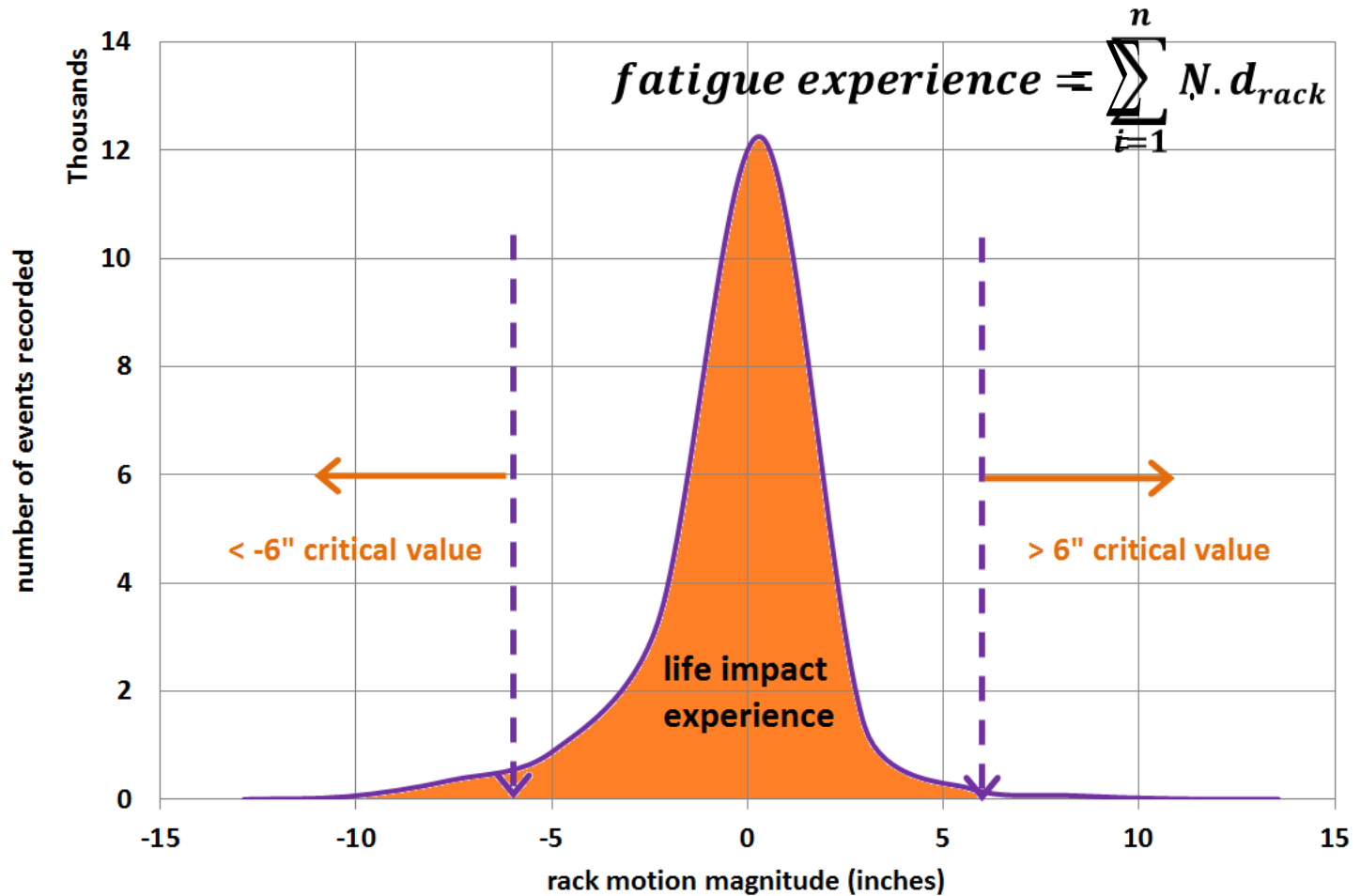


# fatigue (rack) frame motions



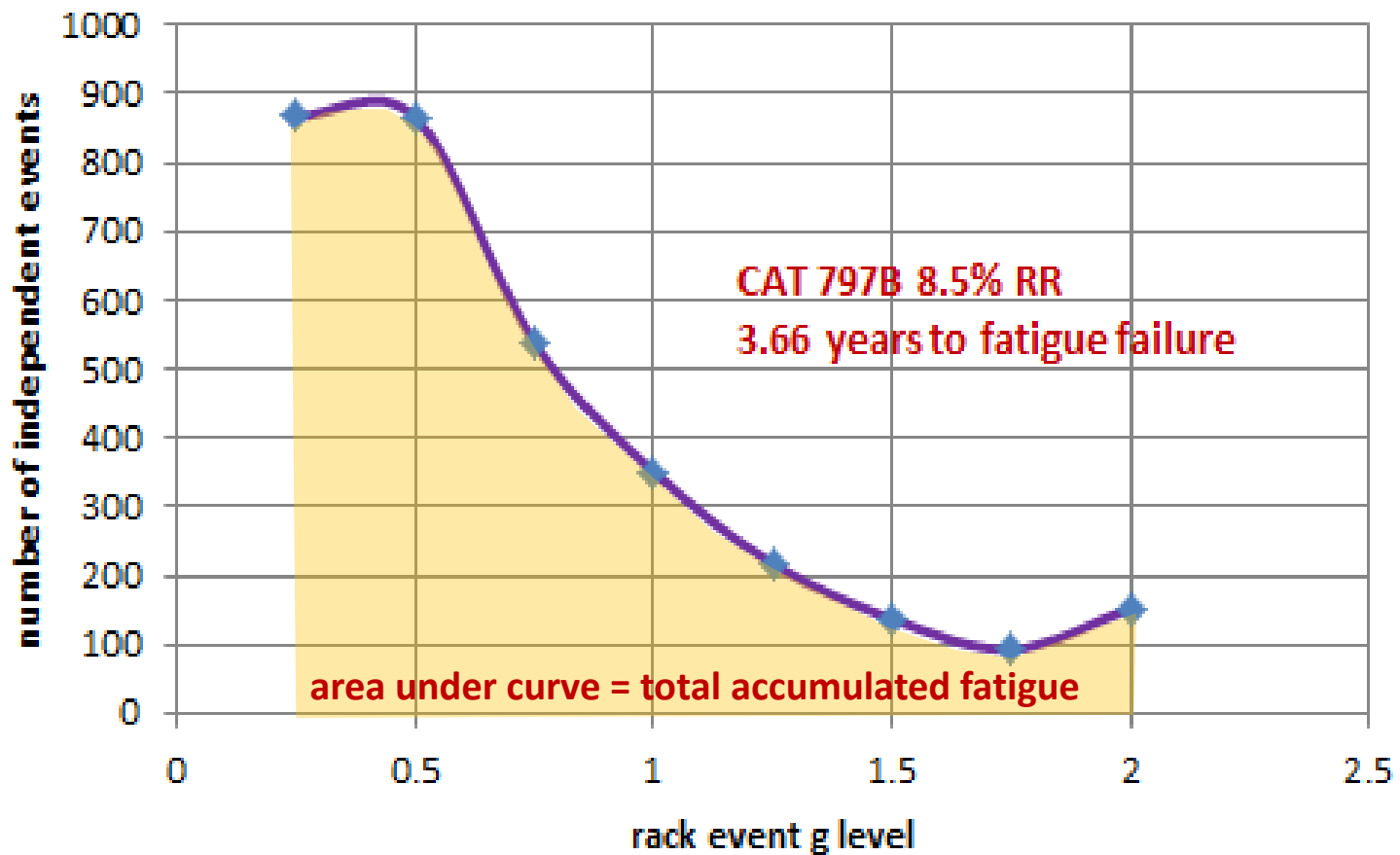


# frame fatigue deformation view

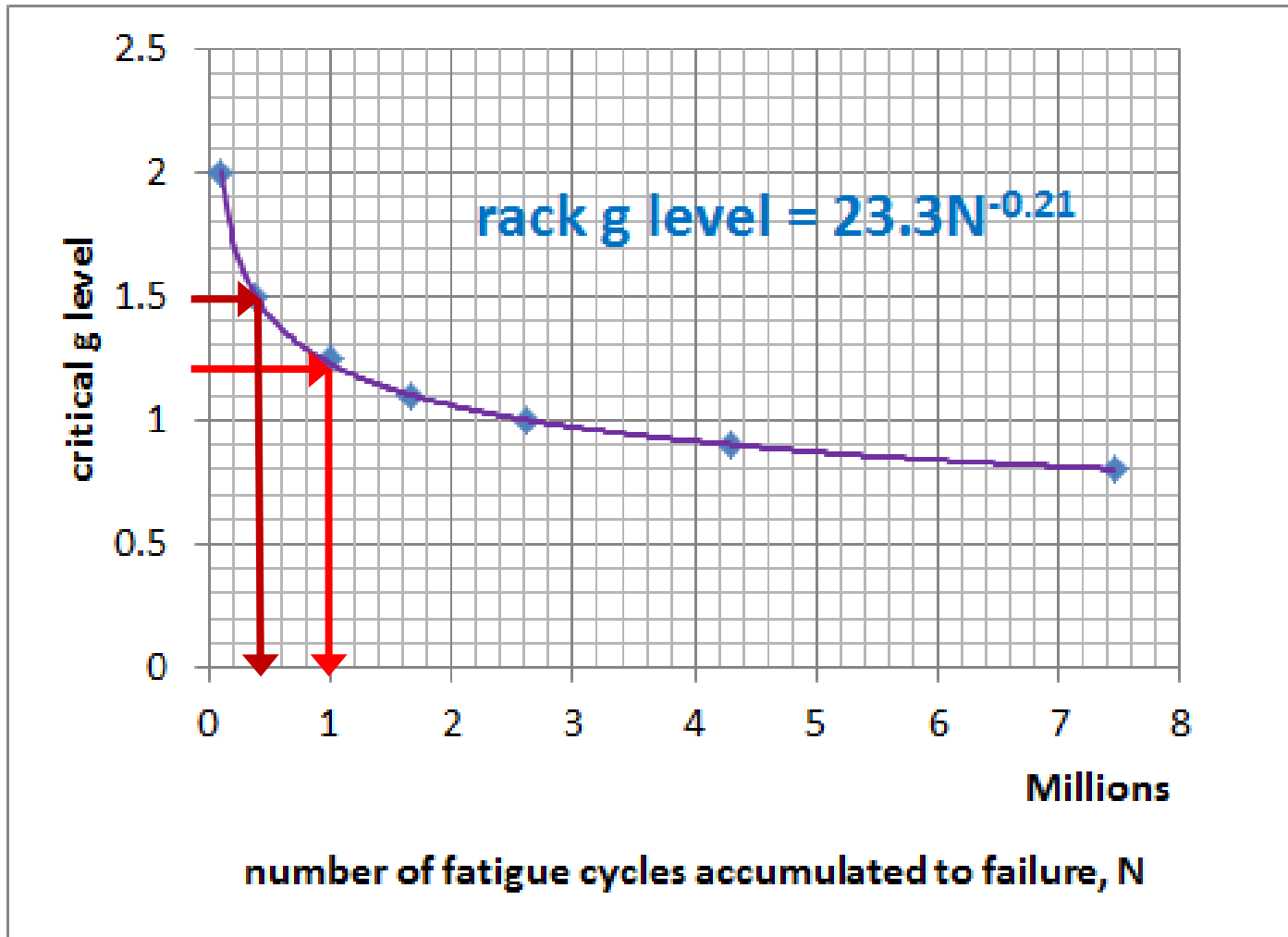


# rack *g-level based* accumulation

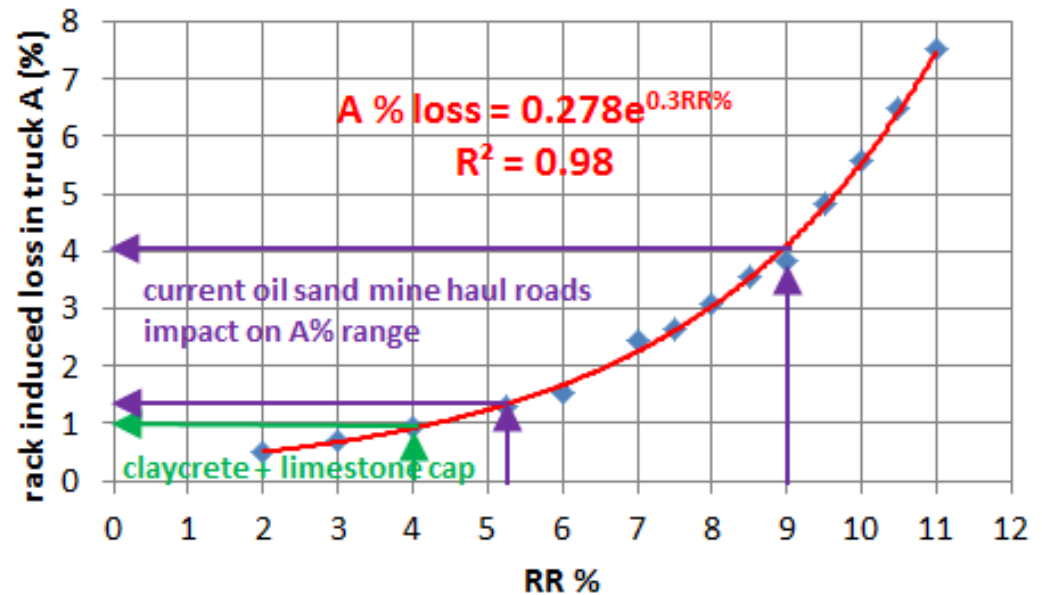
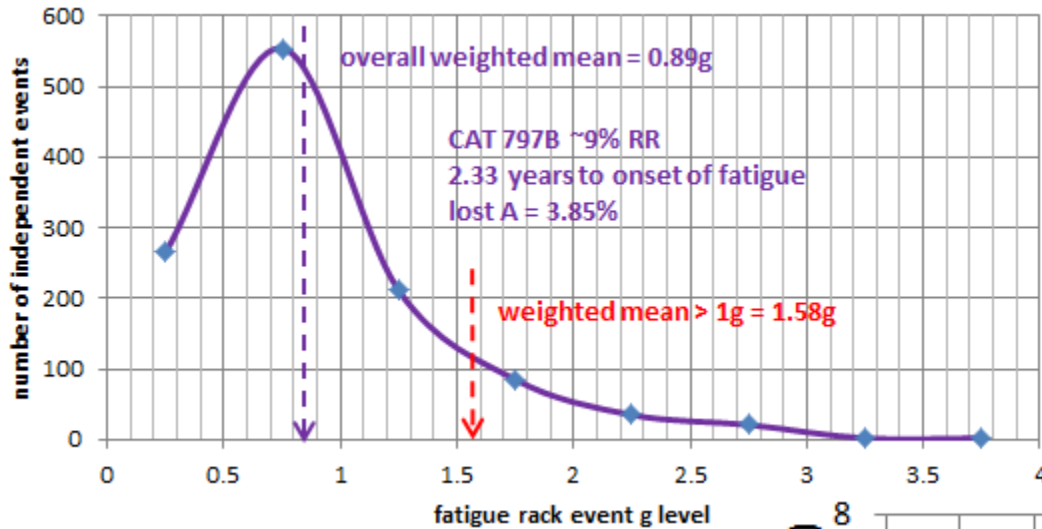
	0.25	0.5	0.75	1	1.25	1.5	1.75	2
% events	26.9	26.9	16.7	10.9	6.7	4.3	2.9	4.7



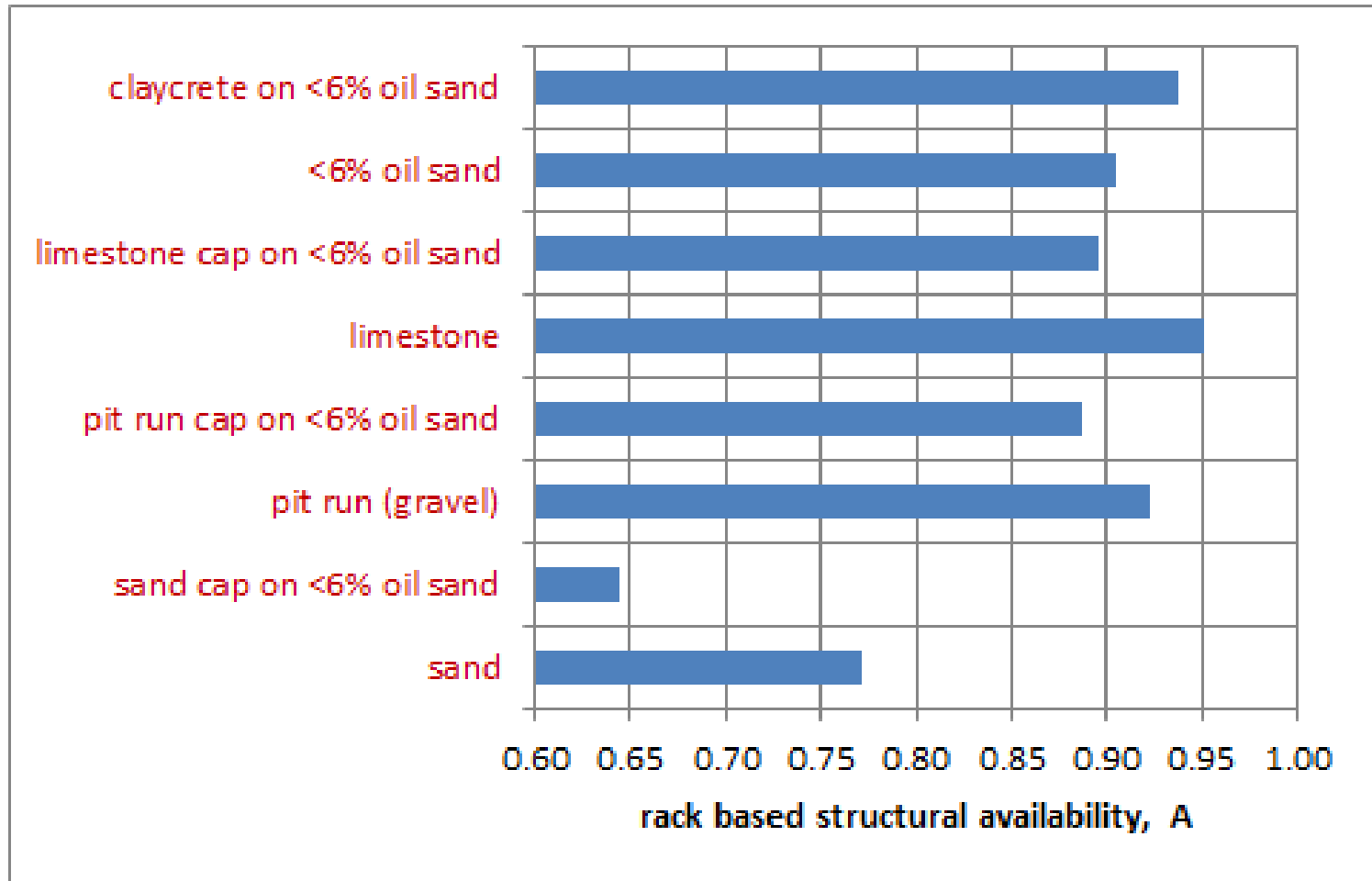
# S-N (twist) fatigue curve *by g-level*



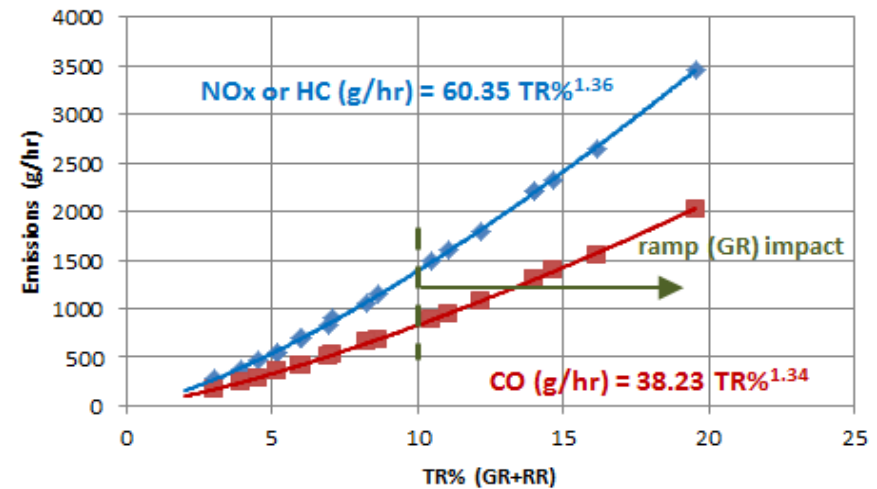
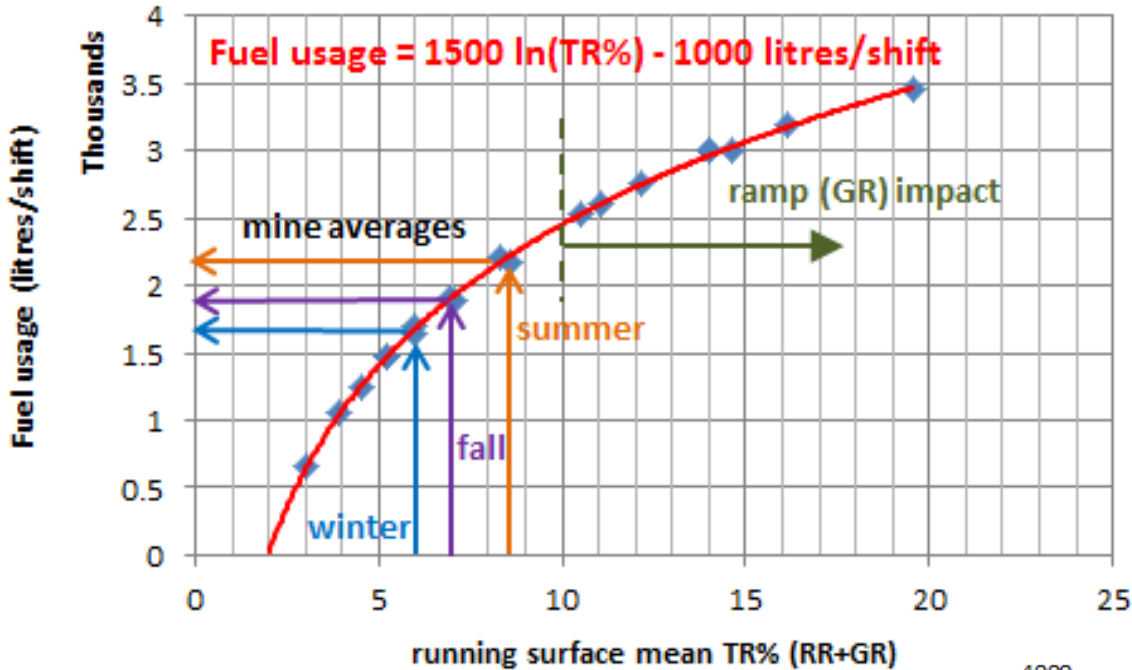
# impact of RR% on hauler Availability



# RR influenced truck Availability



# extended to fuel usage and emissions





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***thank you***

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