Examining the Guard Rails' Effect on Noise and Wheel/Rail Wear at NYCT

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The Team

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WID | WAYSIDE INSPECTION DEVICES

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PROGRESSIVE RAIL TECHNOLOGIES

LTK

Project Objectives

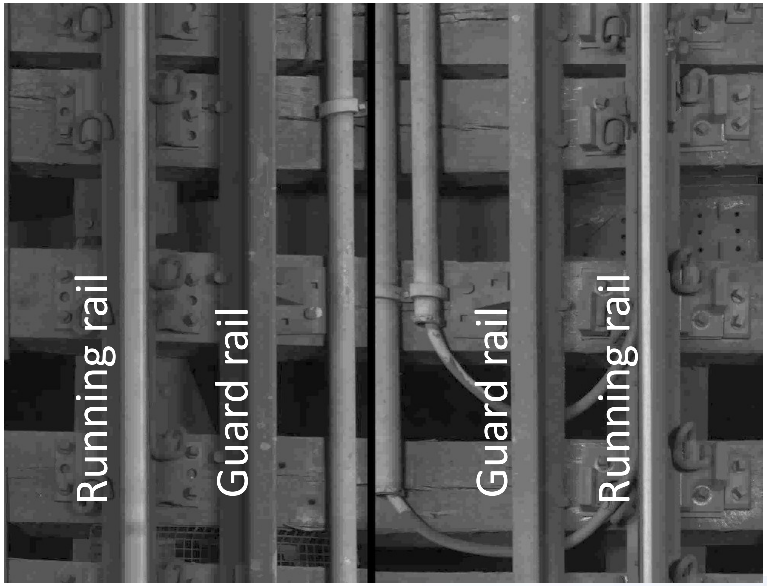
- Objectives
  - Investigate NYCT standards and effectiveness of restraining rails
  - Gain insight into two derailments at Willets Pt turnout
  - Make recommendations regarding use and implementation of restraining rails

Project Tasks

- Instrument track to measure truck behavior and forces on the rails
- Use the measured data to calibrate a model for simulations to evaluate performance over an extended range of conditions
- Deliver recommendations

Clarification of terms

Guard (protection)



Restraining (load bearing)

Questions – Unrestrained Track Sections

- Any indication of high risk or high damage?
- What parameters affect that risk?
- Any commonalities between worse performers?

Questions: Restrained Track Sections

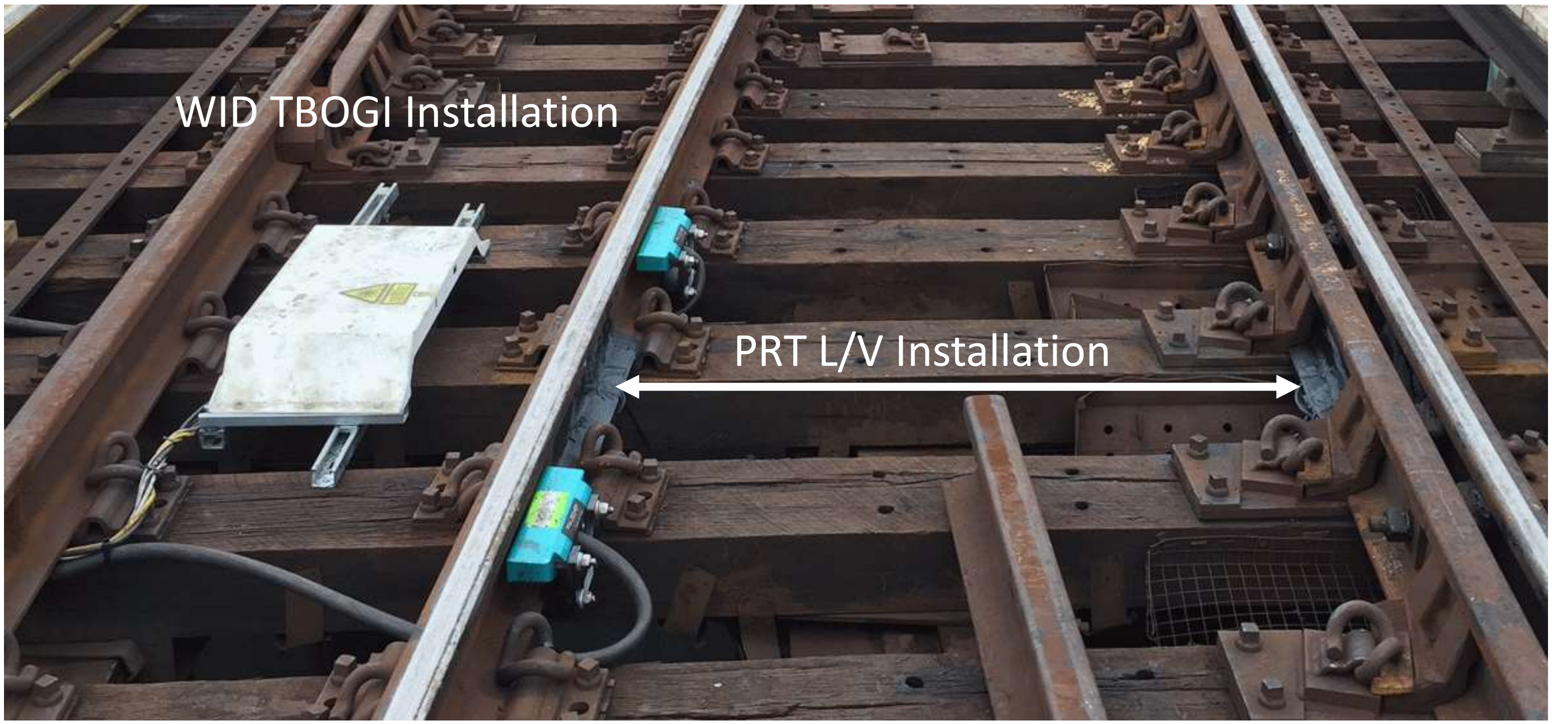
- Some assessment of risk and damage
  - Compare to unrestrained track
  - Any commonalities with-respect-to higher risk actors?
    - Effect of speed?
    - Which axle?
    - Motored versus non-motored?
- Willets Point
  - Indications of higher risk than other restrained track? e.g.
    - low rail unloading
    - lateral forces on restraining rail
    - L/V on restraining rail

Plan

Track	Location	Length (ft.)	Radius (ft.)	S.E. (in.)	Balanced speed (mph)	Posted speed (mph)	Grade (%) (*)
CC2	N/O 34th St.-H.Y.	1220	650	5.00	29	38	2.54
CC1	N/O 34th St.-H.Y.	1220	650	5.00	29	38	-2.41
C1	N/O 46th-Bliss St.	460	490	3.50	21	30	0.00
C1	S/O Hunters Point	305	400	2.00	14	24	-0.50
CC2	Willets Point turnout			0.0		15	-0.50

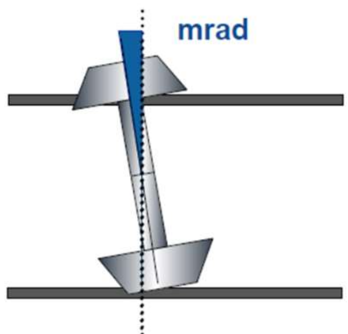
- Wayside instrumentation
- 24 hours install, approx. 8 hours data collection

Wayside instrumentation

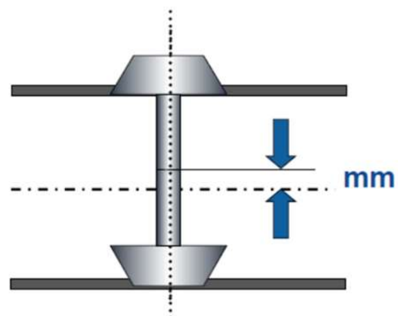


TBOGI Measurements

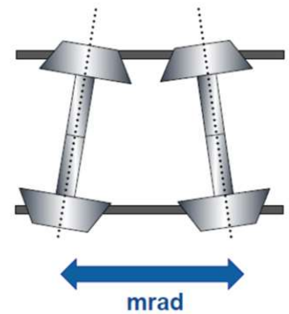
Angle of Attack
AOA



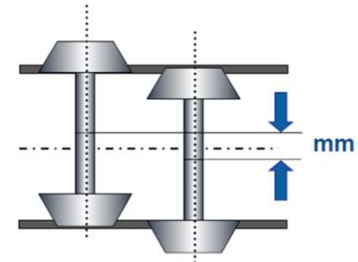
Tracking Position
TP



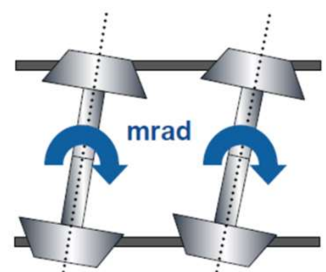
Inter-Axle Misalignment
IAM



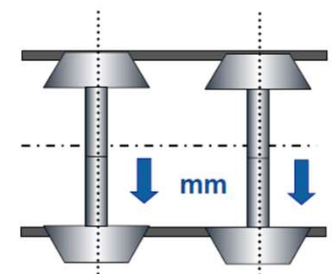
Tracking Error
TE



Rotation
ROT



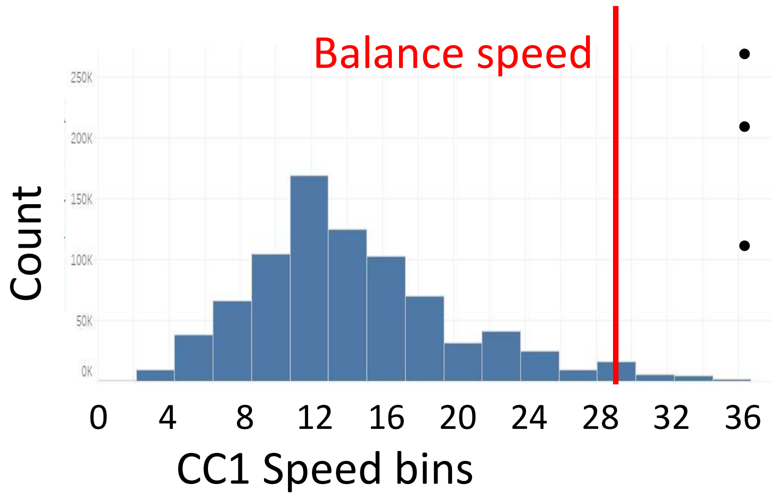
Lateral Shift
SHIFT

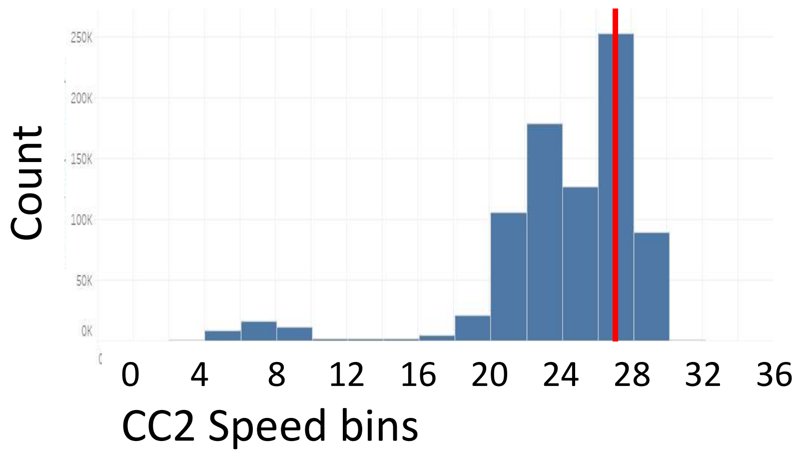


WID WAYSIDE INSPECTION DEVICES

Hudson and 34th (CC1 & CC2)

“UNRESTRAINED” CURVES

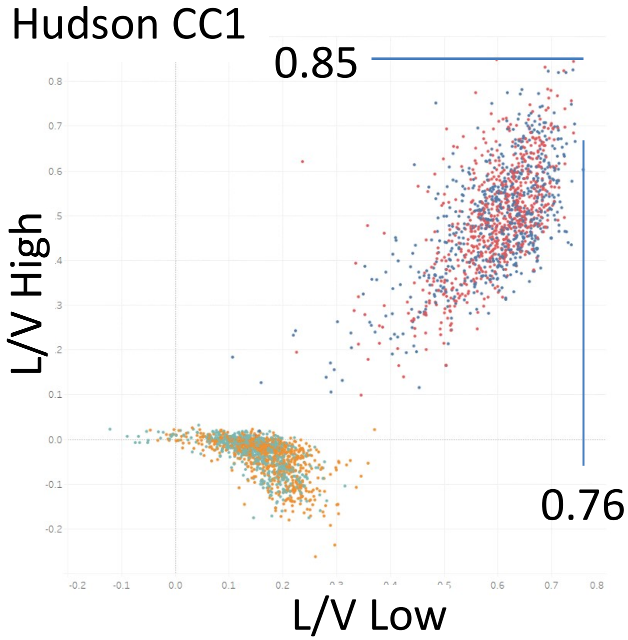


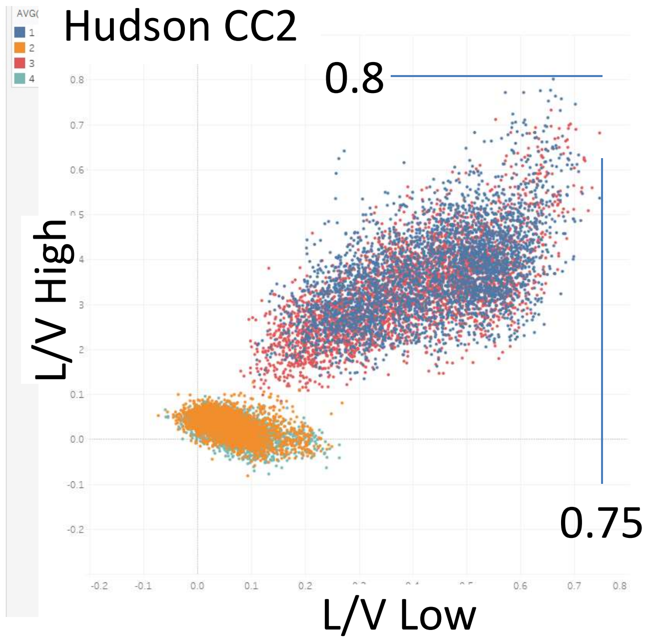


- Curve Radius: 650 feet
- CC1 running primarily under the balance speed
- CC2 running at balance on average

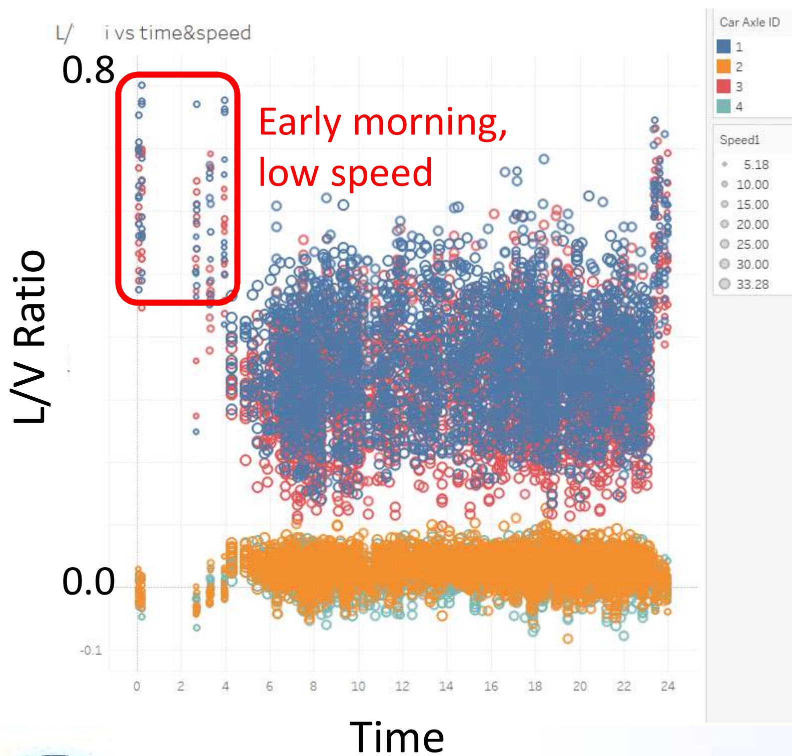
	CC1	CC2
Speed (mph)		
Balance	29	29
Posted	38	38
Min	2	5
Max	35	32
Median	13.3	27.4
Average	14.5	26.1
Grade (%)	-2.41%	2.54%
Track Gauge	1443.4	1438.4
Date	28SEP17	29SEP17

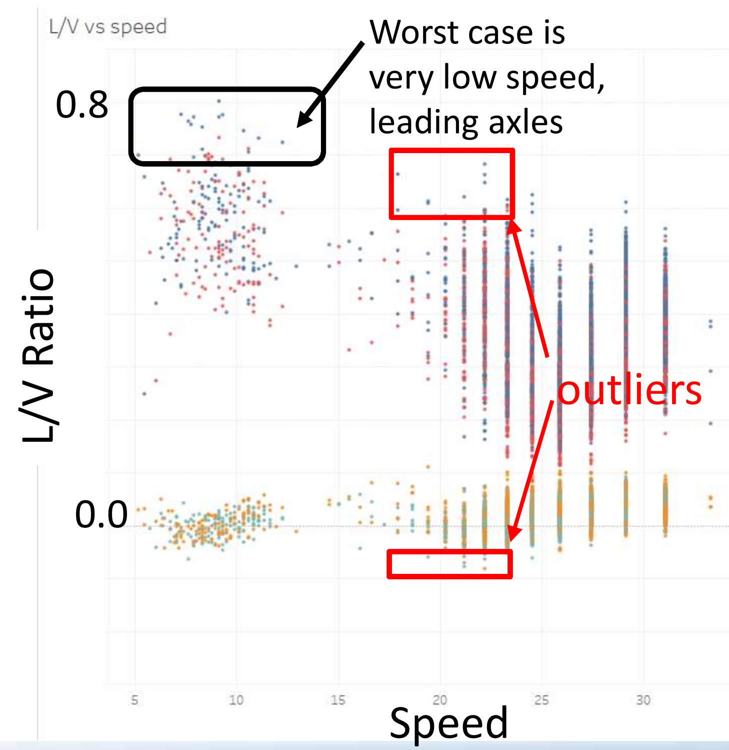
Hudson CC1 and CC2 L/V values





Hudson CC2: L/V analysis





Observations

- Speed has a strong effect on L/V
  - Worst case is slow, underbalance running (highest risk for wheel climb derailment)
- The distributions of L/V values nearly the same for CC1 and CC2
  - Despite difference in speed distribution, track gauge, grade.

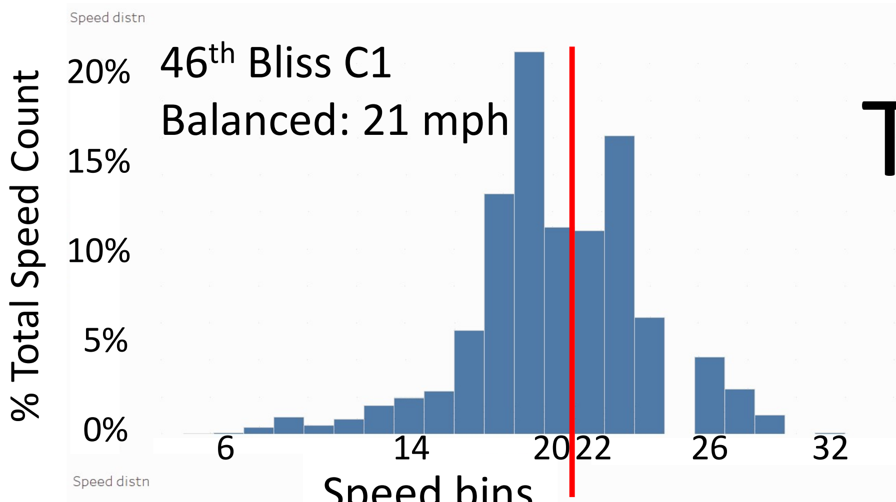
Conclusions – unrestrained curves

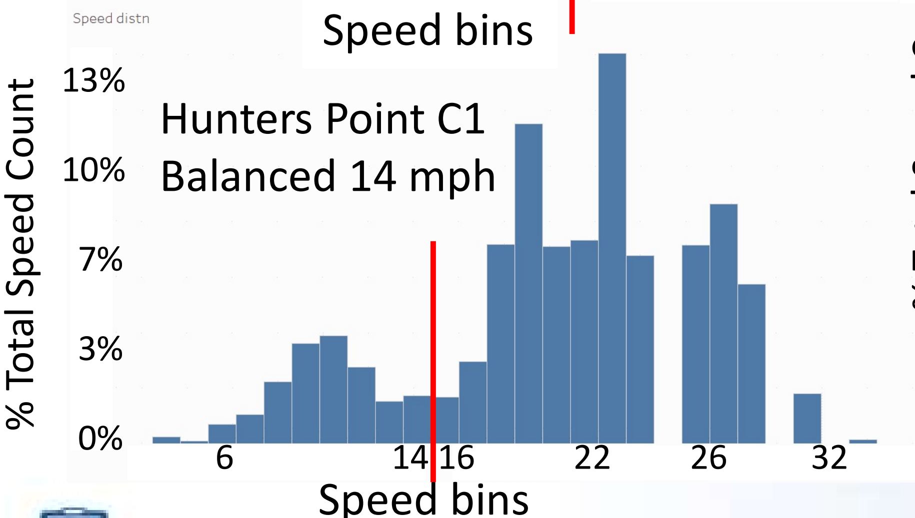
- L/V values are high
  - Median 0.45-0.48 (dry TOR)
  - Peak values 0.6 to 0.8
  - high gage face wear rates (and wheel flange wear)
  - high TOR wear rates, corrugation and noise
- Wheel climb risk?

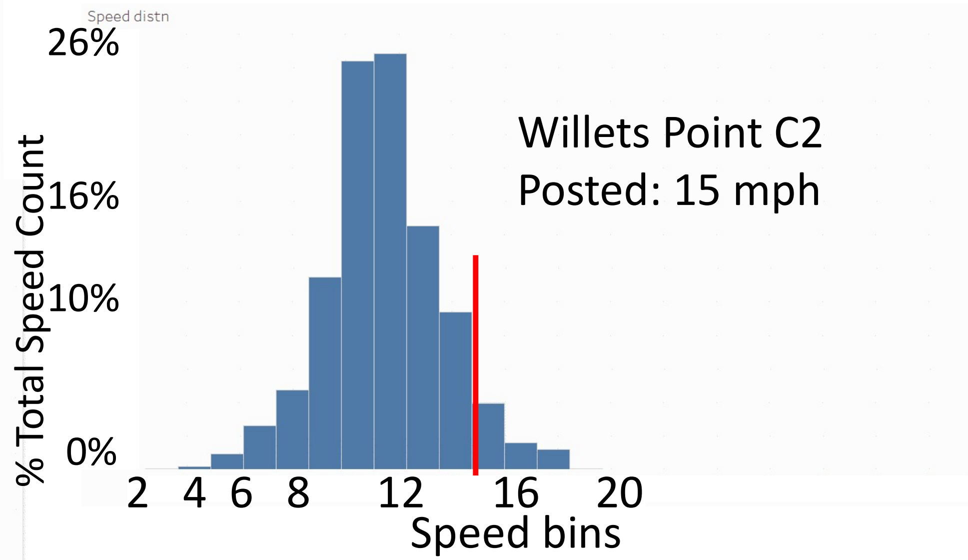
"RESTRAINED" CURVES

Hunters Point C1, 46th/Bliss C1 and Willets Point C2

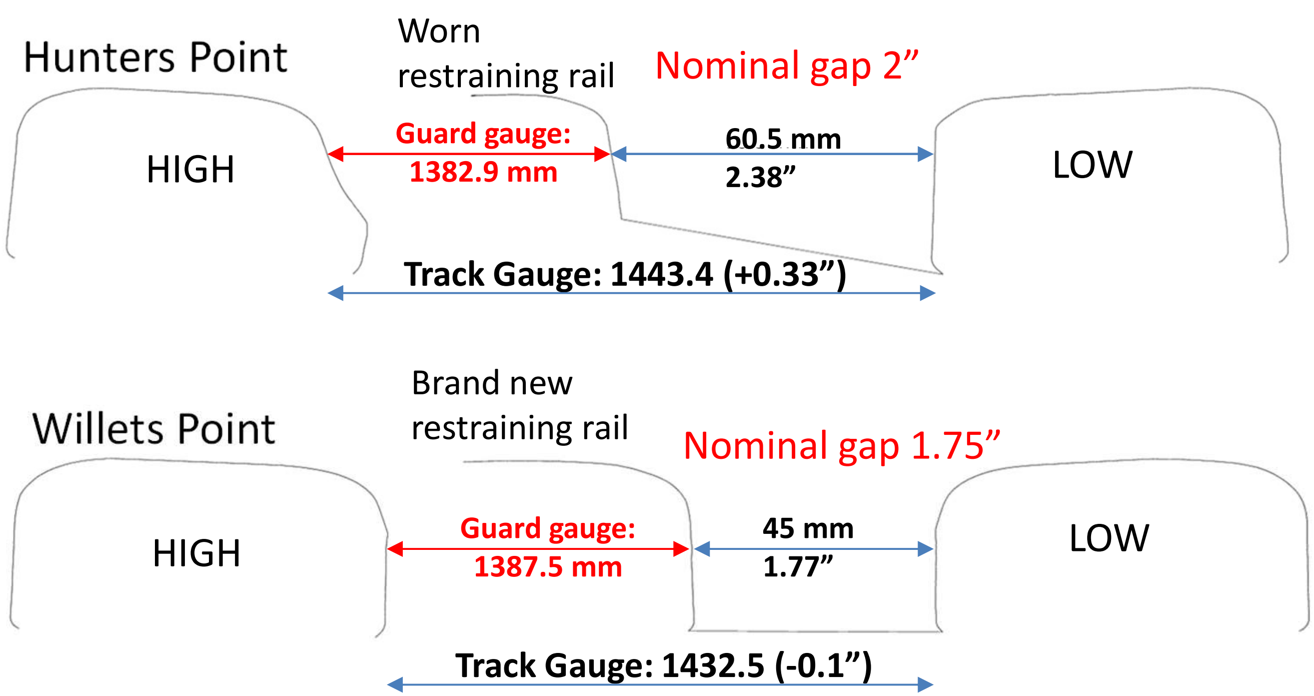
Train Speeds





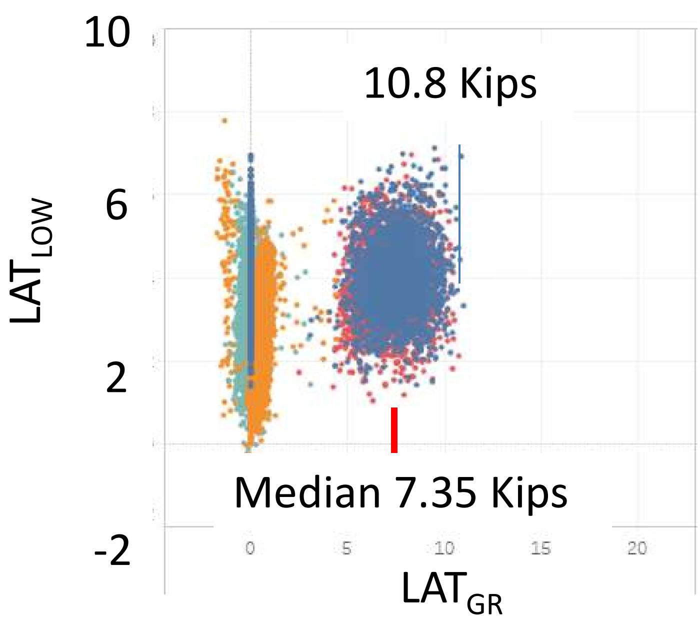


Guarded curves

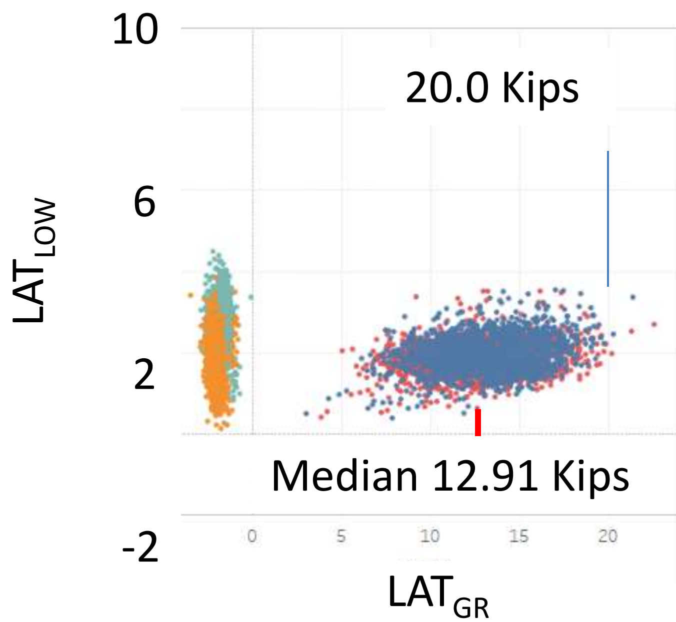


Restraining rail - Lateral force

Hunters Point



Willets Point

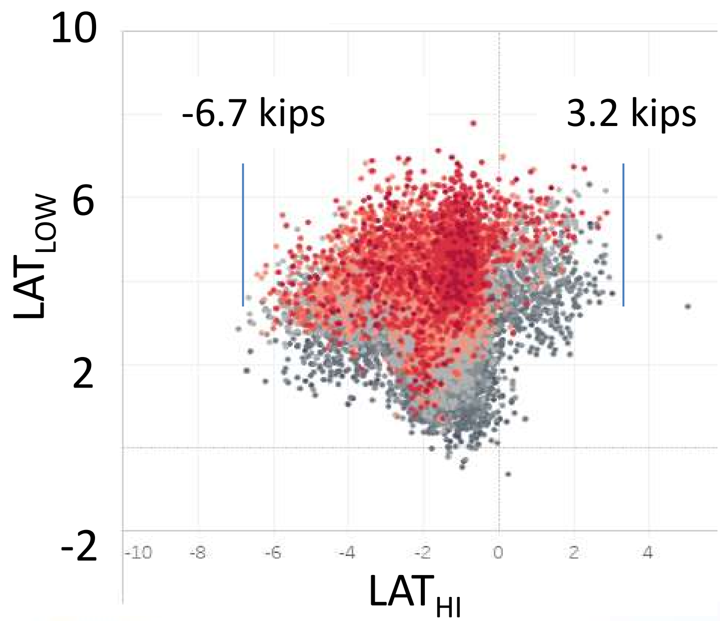


Greater RR wear and risk of climb

- Lateral forces on WP restraining rail are almost twice those of Hunters Point

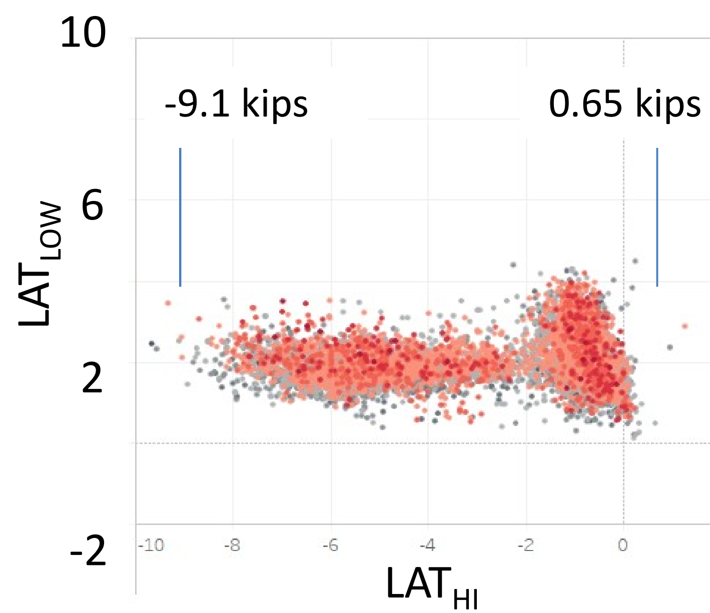
High/Low Rail Lateral Forces

Hunters Point

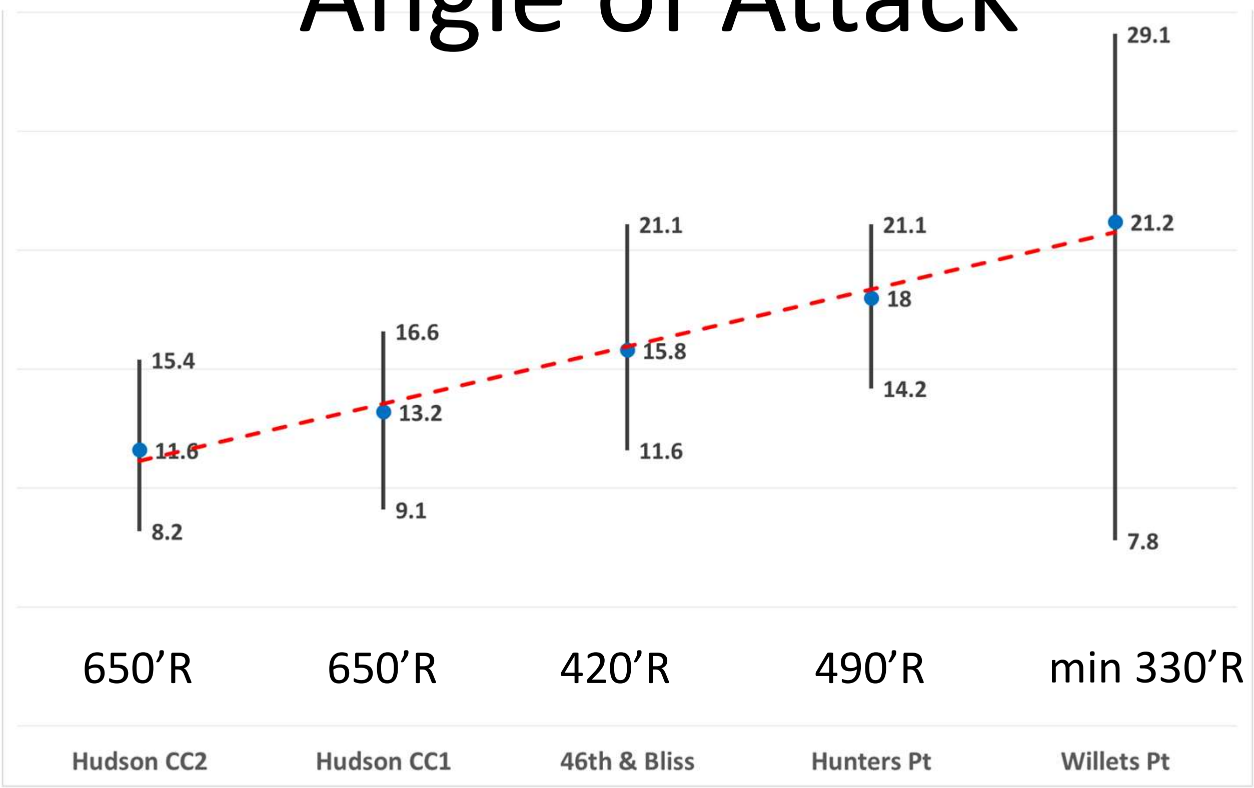


- low HR forces
  - No wheel climb concerns
- WP has highest HR forces but lower LR forces
  - Highest TOR wear

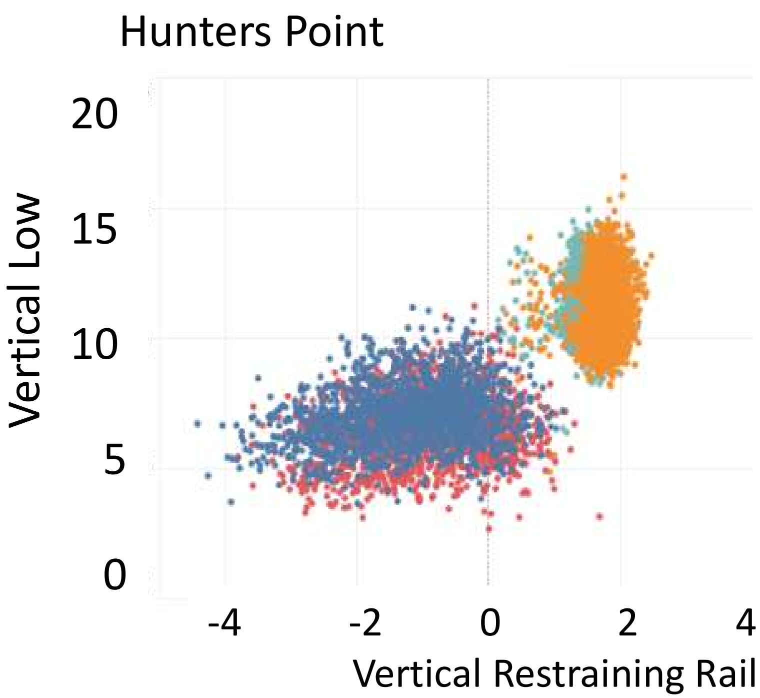
Willets Point

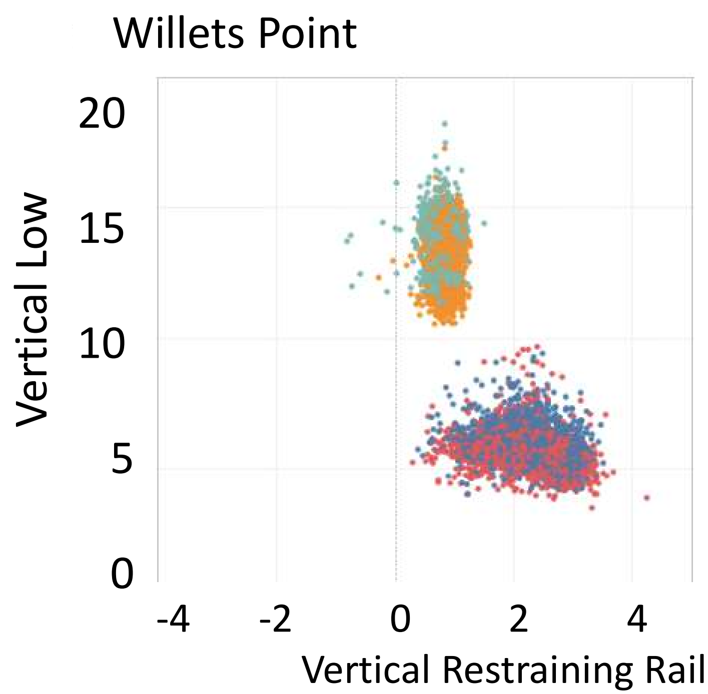


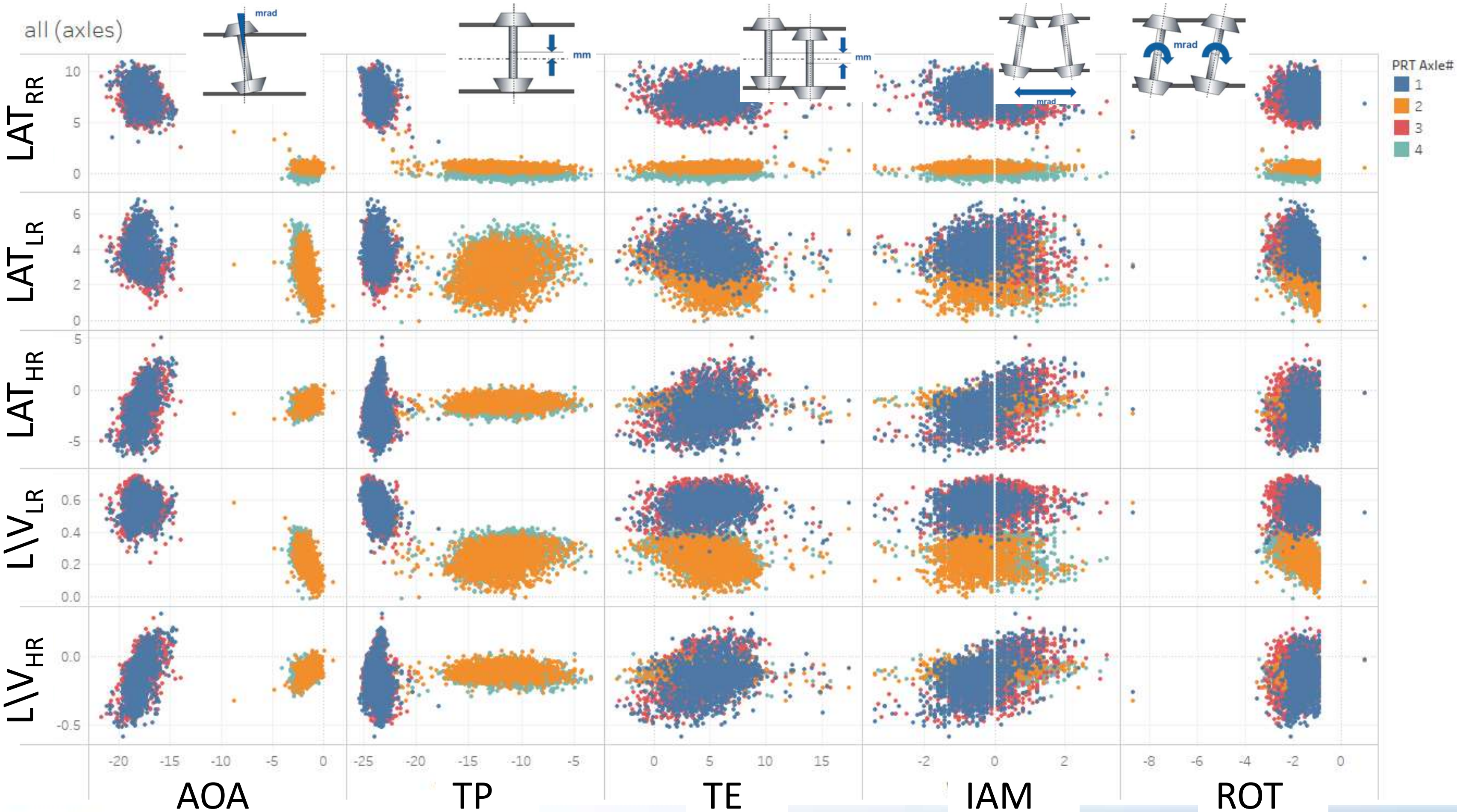
Angle of Attack



Restraining Rail Vertical Force







all (axles)
mrad
mm
mm
mrad
mrad
PRT Axle#
1
2
3
4
LAT RR
LAT LR
LAT HR
L\V LR
L\V HR
AOA
TP
TE
IAM
ROT

Effect of tighter flangeway clearance?

- ✗ Much higher lateral forces on restraining rail
  - – High wear rates during run-in
  - – Greater risk of RR climb
- ✓ Lower lateral forces on high rail
  - - Reduced HR gage-face wear
  - - Reduced wheel climb risk

Impact of motored truck

L/V high > 0.6 Hudson CC2

103		axle # 1	axle # 3
motored	Y	47.6%	22.3%
	N	14.6%	15.5%

Axle 1 of motored truck
If not motored, 1 and 3 are same

Vlow < 5 Willets Point C2

887		axle # 1	axle # 3
motored	Y	17.7%	39.6%
	N	23.3%	19.4%

Axle 3 of motored truck
If not motored, 1 and 3 are same

Effect of speed

- Slow speed
  - highest $(L/V)_{HIGH}$
  - greater damage to low rail from higher V_{LOW}
- High speed
  - Greater vertical load on HR
  - Higher lateral force on RR
  - Lower low rail vertical

Greater Restraining Rail climb risk

Willets Point Derailments – So Far

- Turnout configuration:
  - No superlevation -> Low rail unloading
- New Track Installation:
  - Higher lateral forces (seen by IWS at N/O Willets Point)
  - New RE115 geometry (potentially lower BOF contact angle)
  - Evidence of dry wear (very high friction levels)

Willets Point Derailments – cont'd

- Wheelset commonalities
  - Near end of train
  - Trailing truck
  - Axles powered
  - Outside wheel reached retruing limit for flange wear
  - Possibly lower BOF (lower contact angle)

Risk and Damage With Restraining Rail

- ✓ High Rail Wheel Climb:
  - For restrained curves there is no threat (L/V of 0.8 measured on unrestrained)
- ✗ Low rail unloading – significant if restrained
- ✓ Corrugation – greater on unrestrained
- ✗ RR climb – only applies to restrained

=> inconclusive

Awaiting dynamic modeling for clues re longitudinal forces and wear energy.

Dynamic modeling

Simulation Matrix

Items	Unrestrained		Restrained		
	34th street	Curve 2	Curve 3	Curve 4	34th street
Vehicle (C config)	1	1	1	1	1
Traction / Brake	2	2	2	2	2
Gauge and flangeway	1	1	5	5	5
Track geometry	2	2	2	2	2
Grade	2	2	2	2	2
W/R pairs	3	3	3	3	3
W/R friction combinations	3	3	3	3	3
Speeds	3	3	3	3	3
Cases, subtotal	216	216	1080	1080	1080

Potential Maximum Number of Cases - **3672**

Conclusions

- Wayside instrumentation – 5 sharp curve sites
  - Little useful direct correlations between TBOGI and L/V
- Restraining rail is effective in reducing gage face wear, wheel climb
- Many contributing factors to Willets Point restraining rail climb
- Speed has a strong effect on forces, risk
- Dynamic modeling will better explain compromises

Thanks

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