

Chasing the Magic Wear Rate

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Overview

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Goal

Develop, validate, and use models of wear and surface fatigue to establish guidelines for the integration of the **Magic Wear Rate (MWR)** into track maintenance practices.

- Compare **crack growth rates, wear rates**, and the impact of **grinding** from in-service class 1 railroad data to make valid **simulation models** of each process.
- Develop a tool for MWR guidelines through simulations using these models.

Background



ICRI Field Studies Goals:

- Relate visible surface damage to its depth.
- Relate visible surface damage and risk.
- Integrate new inspection technologies into maintenance practices.
- Establish best practices for grinding new rails.
- Characterize friction conditions in railway operations.
- Relate crack initiation and growth rate with track properties.
- **Develop/validate models of wear and surface fatigue.**
- Quantify the Magic Wear Rate.
- Quantify economic benefits of improved maintenance practices.

Data collection

- Field data collected June, September, and November 2023

Team:

- Class 1 Railroad
- Athena
- Eric Magel
- Evraz
- Global Rail Group
- LB Foster
- LORAM
- NRC
- Plasser American

Test Sites and Data Collected

- **17 initial sites:**
 - Jun, Sep, and Nov 2023
 - Rail profiles (MiniProf)
 - Surface photographs
 - Crack depth (Draisine, MRX, and Athena)
 - Tribometer
 - Estimated yearly MGT
- Rail grinding before Nov
- Focus on 5 sites with desired data

MP	Track	Radius (DoC)	ICRI Field Team Initial RCF Observations	
			High or North	Low or South
103B	Single	269 m (6.5°)	light in mid-gauge	clean
101B	Single	582m (3.0°)	Not noted	clean
101.7T	Single	Tangent	light GCC	light GCC
101A	Single	256 m (6.8°)	Light cracking	very light cracking
93 M2	M2	1,746 m (1.0°)	clean	clean
93 M1	M1	1,746 m (1.0°)	Light GCC	clean
90.00	M1	291 m (6.0°)	light gcc	moderate RCF
89A	M1	388 m (4.5°)	Light cracking	moderate cracking
89.00	M1	269 m (6.5°)	moderate RCF	light RCF
87.00	M1	272 m (6.3°)	Light cracking	Light cracking
86.4T	M1	Tangent	No RCF	No RCF
86.00	M1	426 m (4.1°)	Light GCC, TOR light spalling	Light RCF
85C	M1	426 m (4.1°)	new rail , light GCC	mod RCF, mis
85T	M1	Tangent	No RCF	No RCF
84B	M1	582 m (3.0°)	new rail , very light gcc	mod TOR, mis
84A	M1	403 m (4.3°)	Moderate GCC, TOR light spalling	moderate spalling
83.00	M1	403 m (4.3°)	Light cracking, light spalling	Mild cracking

Rail Surface Condition

Photographs used to determine the qualitative severity of RCF damage at each site based. Demonstration with location 87's high rail shown here.

Field

> 20 MGT >

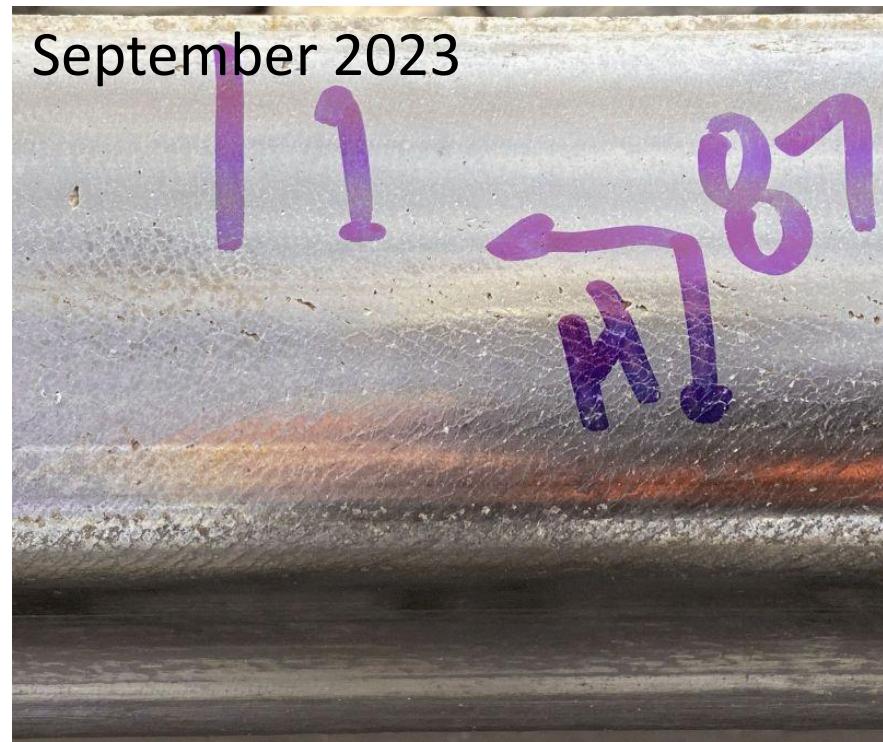
> 11 MGT >

272 m curve high rail

June 2023

September 2023

November 2023



Gauge

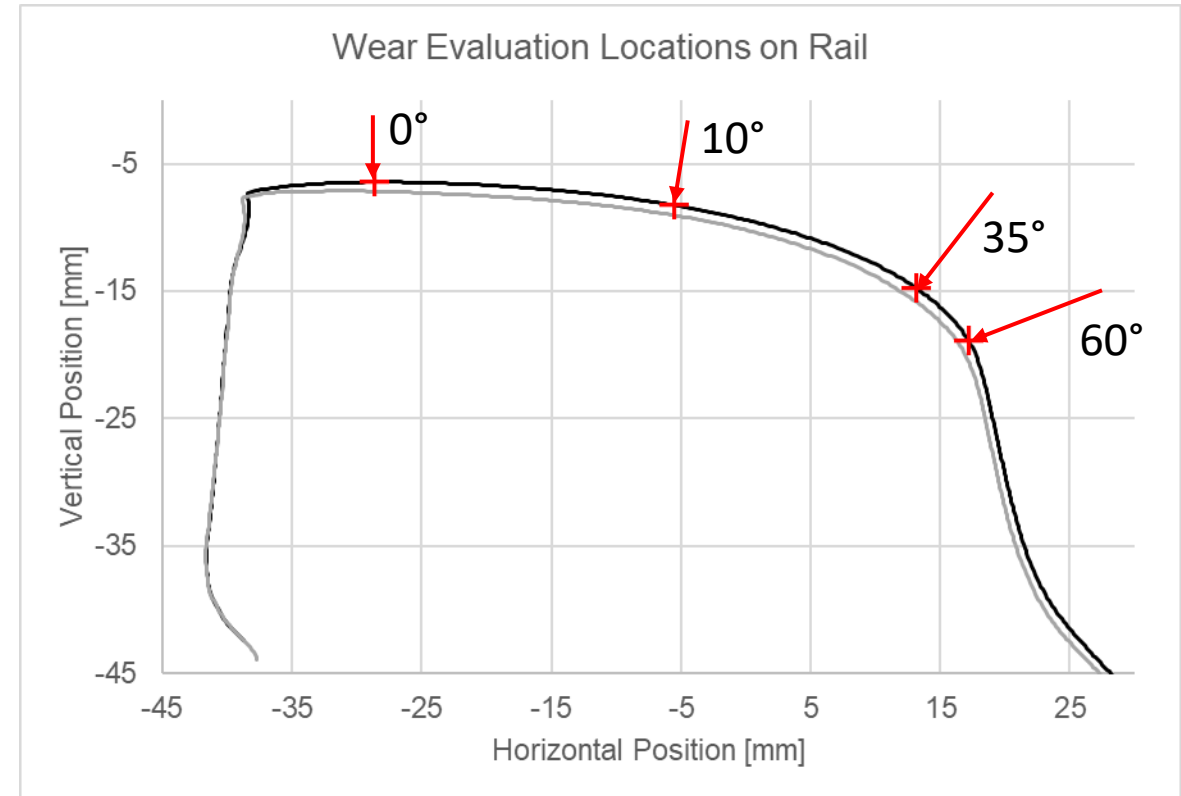
Light RCF

Mild RCF

Some RCF after grinding

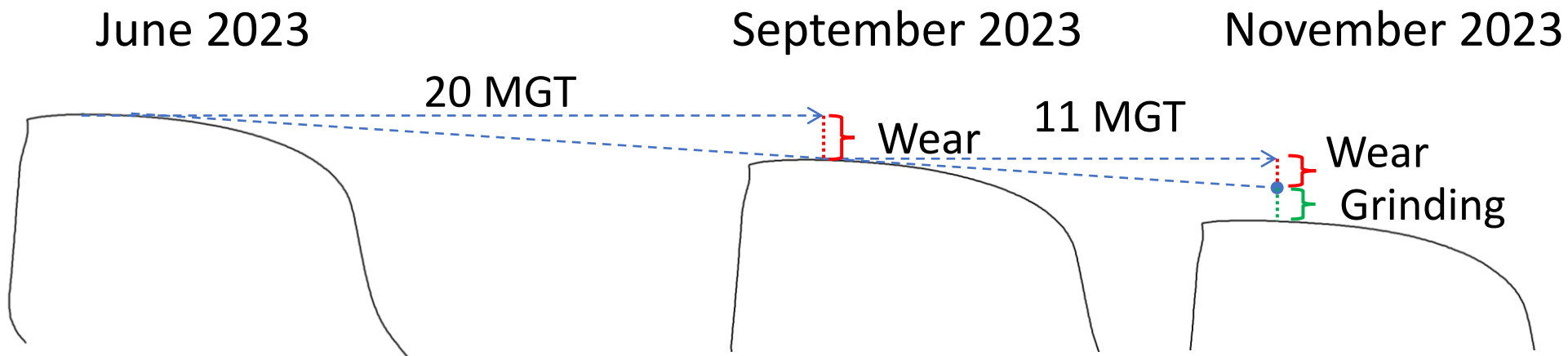
Wear Rate and Grinding Depth Calculations

- Profiles aligned to reference by NRC
- Wear calculated at 0°, 10°, 35°, 60°
- Jun → Sep wear + MGT = wear rate
- Sep → Nov wear & grinding + MGT + wear rate = grinding depth

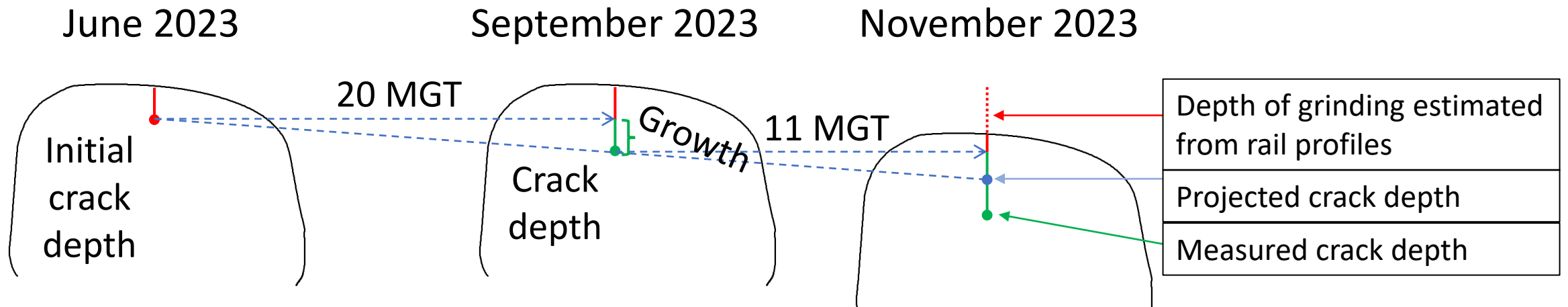


Wear Rate and Grinding Depth Calculations

- Profiles aligned to reference by NRC
- Wear calculated at 0°, 10°, 35°, 60°
- Jun → Sep wear + MGT = wear rate
- Sep → Nov wear & grinding + MGT + wear rate = **Grinding depth**



Crack Growth Calculation



Draisine measurements available in Jun, Sep, Nov at 5 test sites.

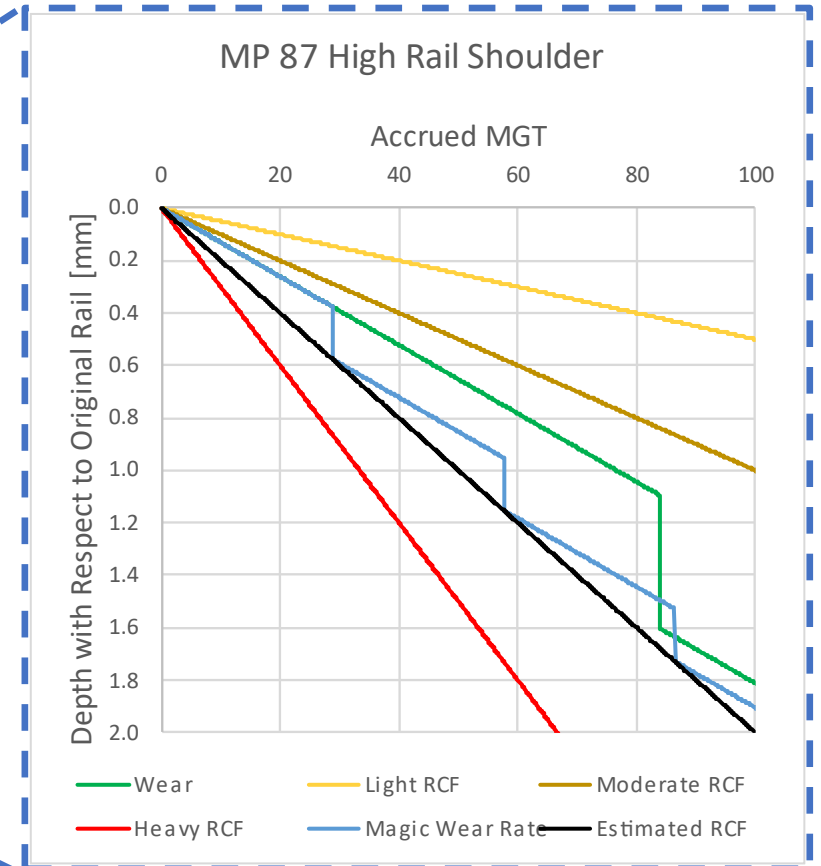
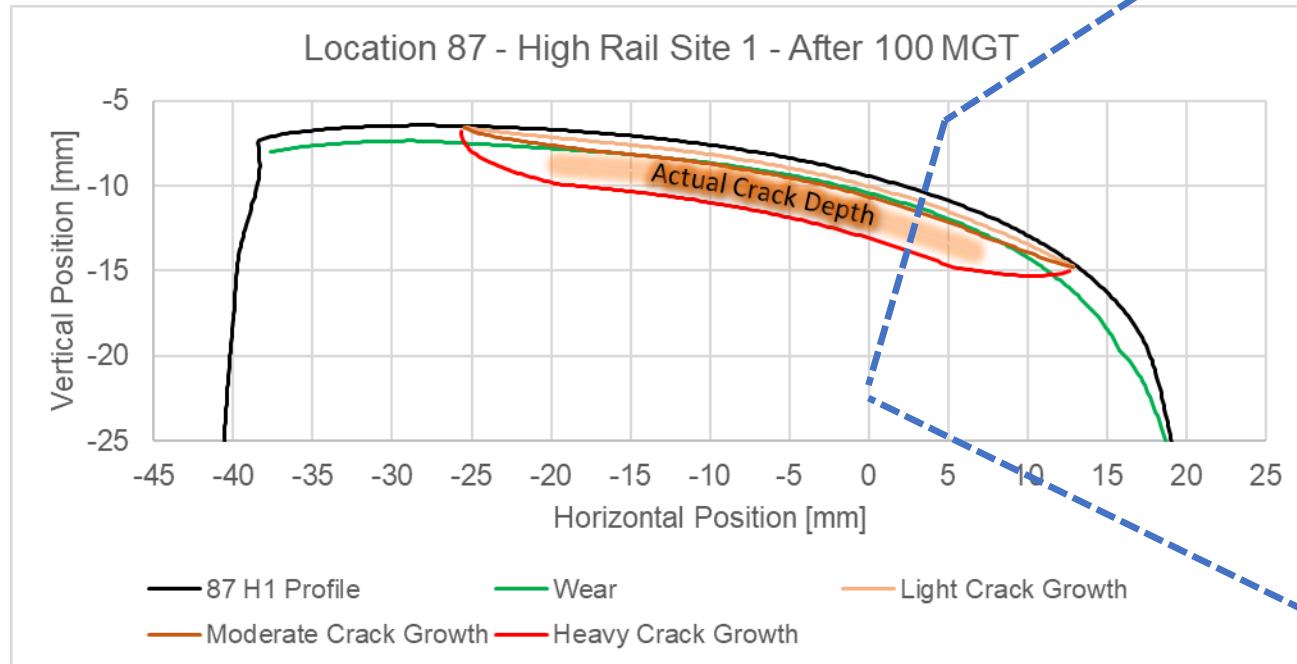
Challenges with crack depth measurements:

- Measured crack depths do not match surface photographs

Location 87- Sharp Curve High Rail

Innotrack's 2006 "Definitive guidelines on the use of different rail grades".

- Light < 0.5 mm / 100 MGT
- Moderate ≤ 1.0 mm / 100 MGT
- Heavy ≤ 3.0 mm / 100 MGT



Conclusions and Next Steps

- Estimated rail wear rates and grinding depth from rail profile data.
- Crack depth rates were estimated with Innotrack instead of Draisine data.
- Produce and validate crack and wear models for the simulations.
- Establish guidelines for the application of the Magic Wear Rate.

Merci / Thank you!

RCF Progression Based on Photographs

- RCF initial state and progression varied for each site.
- Grinding removed portions of the RCF but surface cracks remained visible in some cases.

MP	103B		101B		101.7		101A		93 M2		93 M1		90		89A		89		87		86A		85		84B		84A		83					
Radius (m)	269		582		Tan-		256		1,746		1,746		291		388		269		272		Tan-		426		426		Tan-		582		403		403	
DoC	6.5°		3.0°		gent		6.8°		1.0°		1.0°		6.0°		4.5°		6.5°		6.3°		gent		4.1°		4.1°		gent		3°		4.3°		4.3°	
Rail	H	L	H	L	N	S	H	L	H	L	H	L	H	L	H	L	H	L	H	L	N	S	H	L	H	L	N	S	H	L	H	L	H	L
June	Light	Light	Green	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Yellow	Red	Green	Red	Yellow	Green	Green	Green	Green	Green	Red	Yellow	Yellow	Yellow	Green	Light	Green	Red	Red	Red	Red	Red
September	Yellow	Yellow	Yellow	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Yellow	Red	Green	Red	Red	Red	Green	Yellow	Light	Green	Green	Red	Yellow			Green	Light	Red	Red	Red	Red	Red
November	Yellow	Green	Yellow	Light	Light	Light	Yellow	Green							Green	Yellow	Yellow	Green	Yellow	Green														

RCF damage reduction

Rapid RCF damage

	No data
Light	No or very light RCF
Light	Light RCF
Moderate	Moderate RCF
Heavy	Heavy RCF

Location 101B - Mild Curve High Rail

- ICRI RCF Atlas → enabled detailed crack depth envelope
- RCF managed by 2 single grinding passes/year

