INFLUENCE OF RAIL HARDNESS ON THE WEAR AND ROLLING CONTACT FATIGUE OF RAILWAY COMPONENTS

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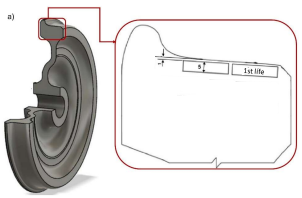
INTRODUCTION

Although strategic, railway freight constitutes only 21% of the Brazilian logistics matrix. Driven by agribusiness, optimizing infrastructure is crucial to reduce high maintenance costs, exemplified by local operator. This study evaluates the wear and rolling contact fatigue (RCF) behavior of a commercial forged wheel tested against premium and super-premium rails using a twin-disc tribometer. By analyzing the active wear mechanisms, this work aims to provide data to enhance the durability and safety of railway operations (ANTF, 2025; CEPEA, 2024; Fracalossi, 2017; Lewis et al, 2019).

MATERIALS AND METHODS



Material	Pre-test hardness (Hv)
Wheel	416 ± 18
Premium Rail	395 ± 10
Super-premium rail	438 ± 12

Figure 1. Schematic of the sampling locations for (a) railway wheel and (b) rail specimens. Dimensions in mm.

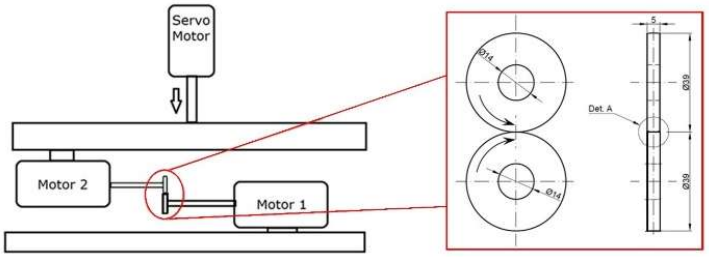


Figure 2. Twin-disc wear test configuration.

RESULTS

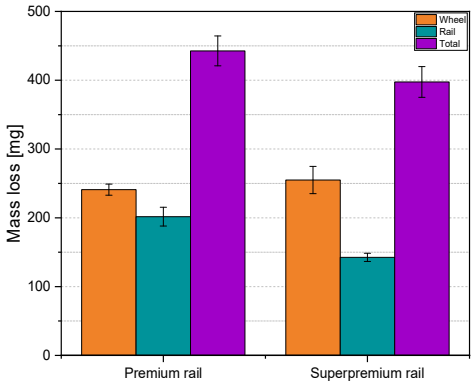


Figure 3 – Mass loss of the wheel and the premium and super-premium rails

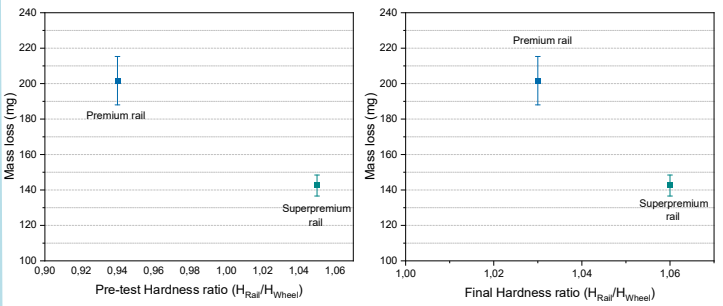


Figure 4. Correlation between the rail/wheel hardness ratio and rail mass loss: (a) initial hardness ratio, pre-test; (b) final hardness ratio, post-test.

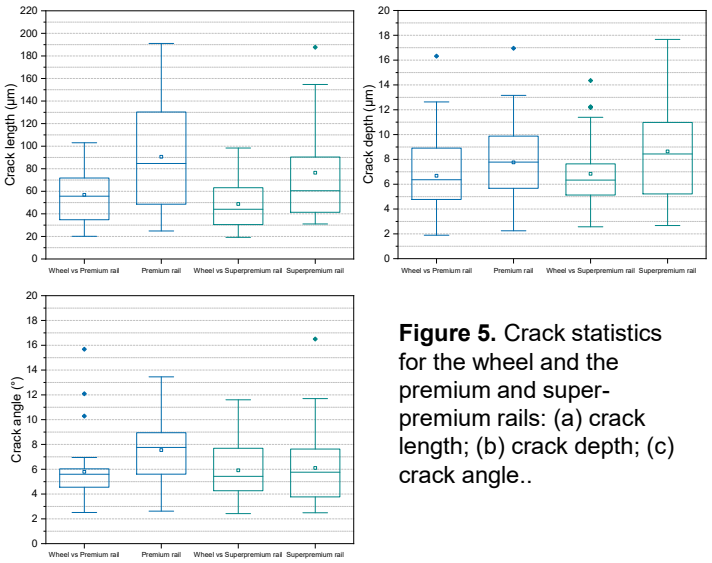


Figure 5. Crack statistics for the wheel and the premium and super-premium rails: (a) crack length; (b) crack depth; (c) crack angle..

CONCLUSIONS

Utilizing a super-premium rail significantly reduces rail wear without increasing the wheel's mass loss. The study demonstrates that wear behavior correlates with both the initial hardness ratios and the hardness of the work-hardened layers. Furthermore, higher rail hardness effectively mitigates rolling contact fatigue by decreasing surface crack lengths on both the wheel and the rail, while crack depths and propagation angles remain unaffected. Ultimately, these findings emphasize the critical role of material selection and work-hardening dynamics in optimizing the lifespan of railway components.

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