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Quantification of the influence of rolling stock failures on track deterioration

Key words: Rolling stock failure; Track deterioration; Quantification; Track charging; Wheel flat

Graphical abstract

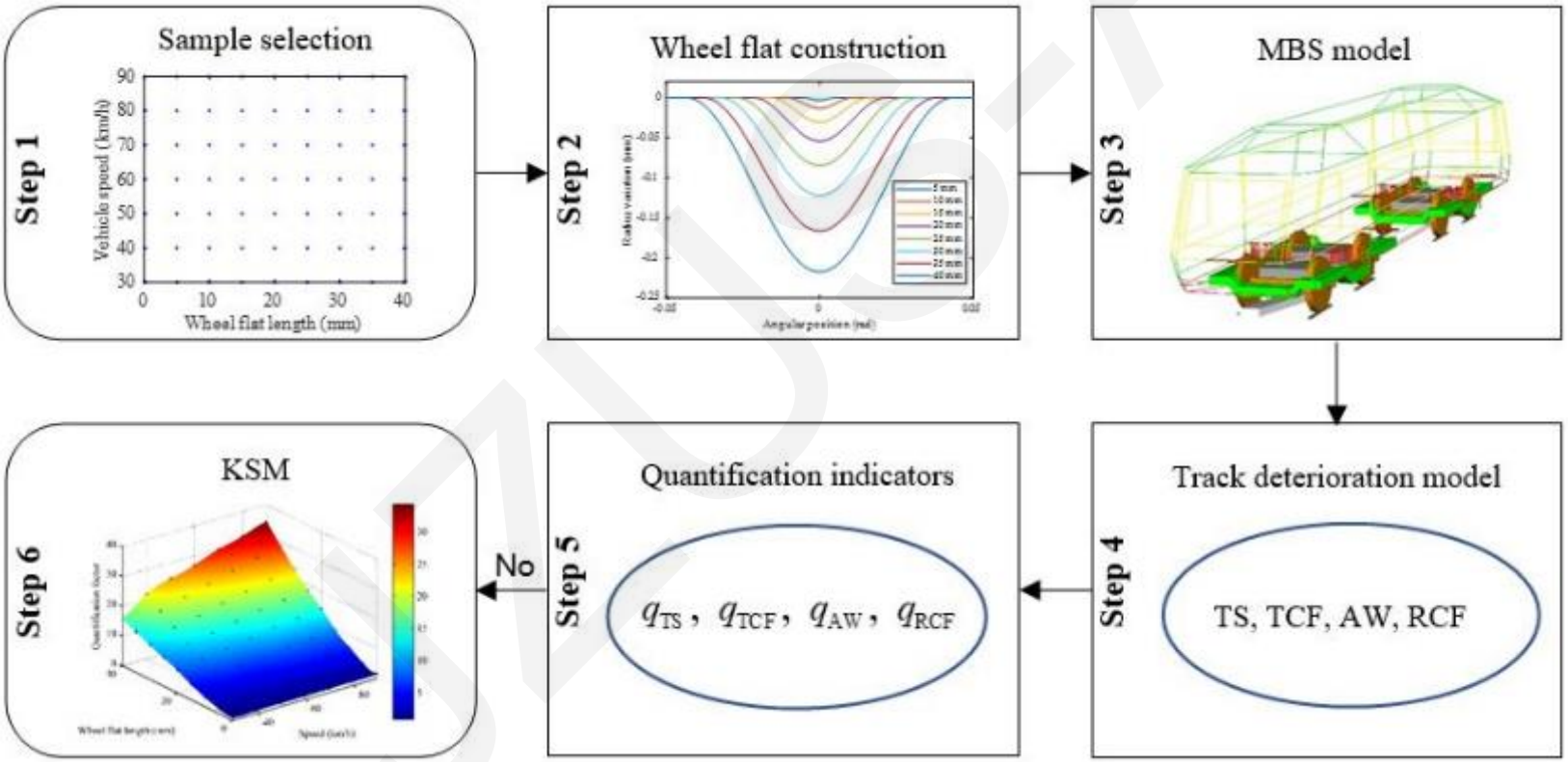

Figure 1. Graphical abstract of the work.

Research purpose

Understanding and quantifying the underlying engineering characteristics of rail track deterioration are critical aspects of improving train safety, advancing maintenance strategies, and optimizing track access charging. However, current quantitative methods do not consider the irregular interaction between rolling stock and infrastructure, which could be caused by rolling stock failures (RSFs). This study focuses on the quantification of the influence of RSFs on railway infrastructure. Taking the wheel flat, a common RSF, as an example, we analyze four quantification indicators that can be used to evaluate track deterioration.

Research method

Multibody dynamics simulation:

a locomotive/track coupled dynamics model

Quantification indicators:

track settlement (TS), track component fatigue (TCF), abrasive wear (AW), and rolling contact fatigue (RCF)

Quantification method:

Kriging surrogate model

Results and conclusion

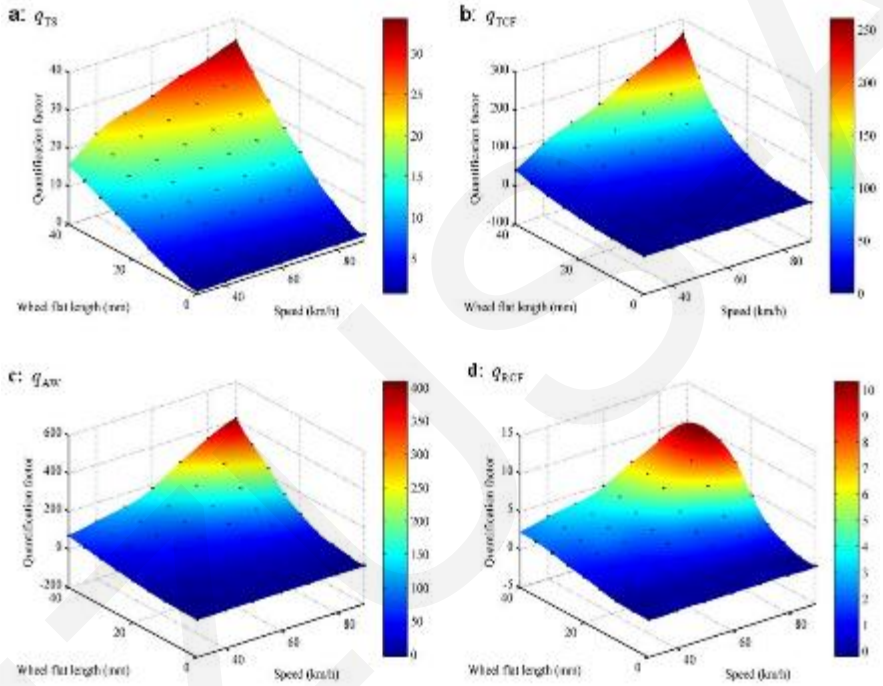

Figure 2. Results.

- Based on a locomotive/track coupled dynamics model, the results show that the wheel flat has a significant influence on track deterioration. More specifically, TS, TCF, and AW increase sharply with the increase of the wheel flat length and the vehicle speed, and this increasing trend becomes more acute with the increase of the wheel flat length and the vehicle speed. At low speeds, RCF increases gradually as the wheel flat length increases; at high speeds, it increases sharply at first and then decreases gradually. The influence of the wheel flat on TCF and AW is the most obvious, followed by TS and RCF.

Related work

- Ye, Y., Shi, D., Krause, P., Tian, Q., Hecht, M. 2019. Wheel flat can cause or exacerbate wheel polygonization. *Vehicle System Dynamics*, 1-30. [doi:10.1080/00423114.2019.1636098]
- Ye, Y., Shi, D., Krause, P., Hecht, M. 2019. A data-driven method for estimating wheel flat length. *Vehicle System Dynamics*, 1-19. [doi:10.1080/00423114.2019.1620956]
- Ye, Y., Sun, Y., Dongfang, S., Shi, D., Hecht, M. 2020. Optimizing wheel profiles and suspensions for railway vehicles operating on specific lines to reduce wheel wear: a case study. *Multibody System Dynamics*, 1-32. [doi:10.1007/s11044-020-09722-4]
- Ye, Y., Qi, Y., Shi, D., Sun, Y., Zhou, Y., Hecht, M., 2020. Rotary-scaling fine-tuning (RSFT) method for optimizing railway wheel profiles and its application to a locomotive. *Railway Engineering Science*, 28: 160–183. [doi:10.1007/s40534-020-00212-z]
- Ye, Y., Sun, Y., 2020. Reducing wheel wear from the perspective of rail track layout optimization. *Proceedings of the Institution of Mechanical Engineers, Part K: Journal of Multi-Body Dynamics*, 1-18. [doi:10.1177/1464419320956831]