Formation process, key influencing factors, and countermeasures of high-order polygonal wear of locomotive wheels

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Background



Fig. 1 Typical polygonal wear wheels with 18, 19 and 24 harmonics, respectively, from left to right. (a) Described in the polar coordinate system and (b) the 1/3-octave band spectrum of the measured irregularities.



Formation and development process



Fig. 2 Formation and development process of wheel polygonal wear.



Countermeasures: Improving the structure of the wheelset



Fig. 3 Comparison of the original and the newly designed wheels.



Countermeasures: Improving the quality of wheel re-profiling



Fig. 5 Center wavelength in 1/3 octave bands measured (a) be-fore and (b) after wheel re-profiling by using type-B underfloor wheel lathe.

$$\begin{cases} x_{wo} = \frac{(R_{r} + r)^{2} - (R_{1} + r)^{2}}{4d} \\ y_{wo} = \sqrt{(R_{r} + r)^{2} - \left[\frac{(R_{r} + r)^{2} - (R_{1} + r)^{2}}{4d} - d\right]^{2}} \end{cases}$$



Conclusions

- The natural vibration of the wheelset is the inherent factor of wheel polygonisation. Poor re-profiling quality is the key external factor.
- The first bending vibrations of the wheelset can be excited by the remaining polygonal wear after wheel re-profiling, which results in the rapid development of wheel polygonisation.
 - Improving the structure of the wheelset and the quality of wheel re-profiling are two main countermeasures.



Related references

- Gongquan Tao, Zefeng Wen, Xuesong Jin, et al. Polygonisation of railway wheels: a critical review. Railway Engineering Science, 2020, doi: 10.1007/s40534-020-00222-x
- Gongquan Tao, Chenxi Xie, Hengyu Wang, et al. An investigation into the mechanism of high-order polygonal wear of metro train wheels and its mitigation measures. Vehicle System Dynamics, 2020, doi: 10.1080/00423114.2020.1770810
- Gongquan Tao, Zefeng Wen, Xiren Liang, et al. An investigation into the mechanism of the out-of-round wheels of metro train and its mitigation measures. Vehicle System Dynamics, 2019, 57(1): 1-16.
- Gongquan Tao, Zefeng Wen, Guosheng Chen, et al. Locomotive wheel polygonisation due to discrete irregularities: simulation and mechanism. Vehicle System Dynamics, 2020, doi: 10.1080/00423114.2020.1737148
- Gongquan Tao, Linfeng Wang, Zefeng Wen, et al. Experimental investigation into the mechanism of the polygonal wear of electric locomotive wheels. Vehicle System Dynamics. 2018, 56(6): 883-899.
- Gongquan Tao, Linfeng Wang, Zefeng Wen, et al. Measurement and assessment of out-of-round electric locomotive wheels. Proc Inst Mech Eng F: J Rail Rapid Transit, 2018, 232(1): 275-287.



