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Influence of wheel polygonal wear on interior noise of high-speed trains

Key words: High-speed train, Wheel polygonal wear, Wheel re-profiling, Interior noise, Wheel/Rail noise, Hybrid FE-SEA

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Experiment

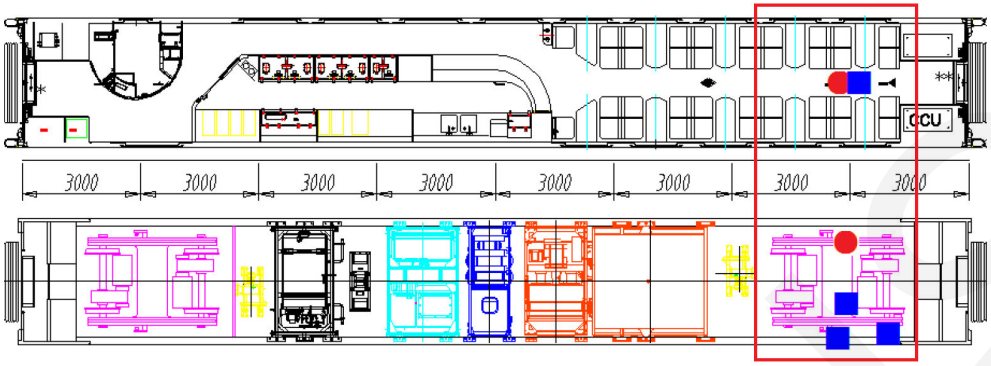

Fig. 1 Measuring points on the high-speed coach

Fig.2 Wheel roughness measurement

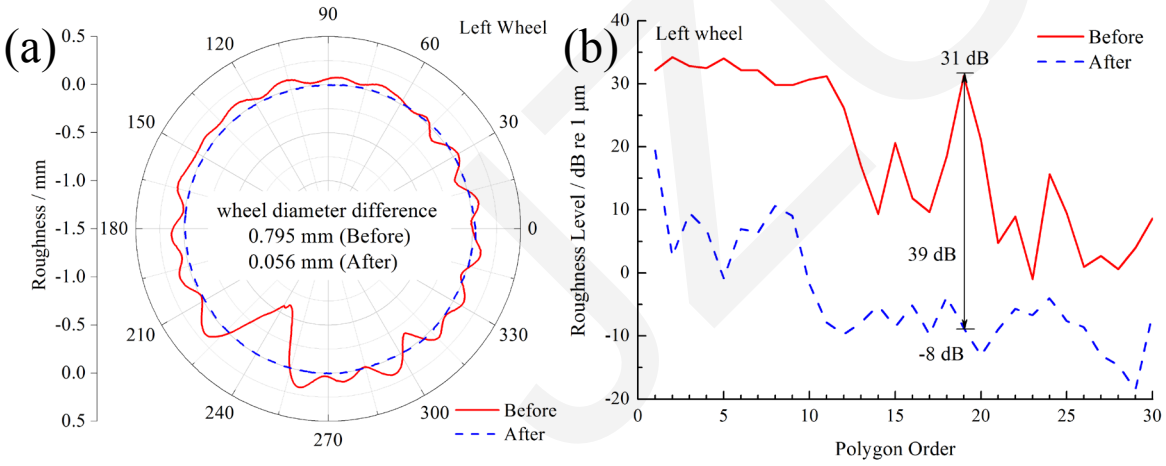

Fig. 3 (a) wheel roughness, (b) polygon order before and after the re-profiling

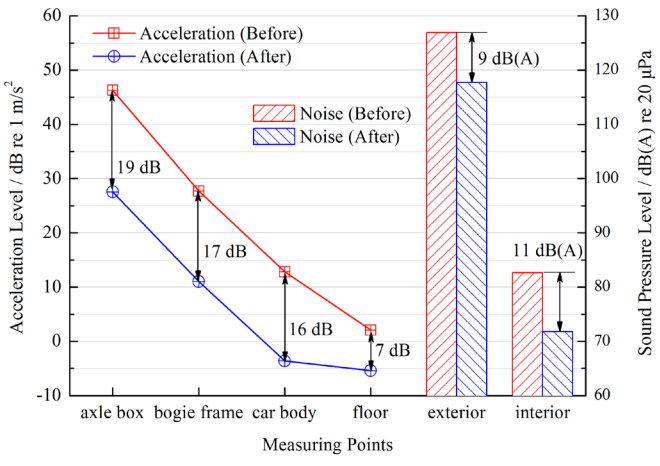

Fig. 4 Noise and vibration before and after the re-profiling

Simulation

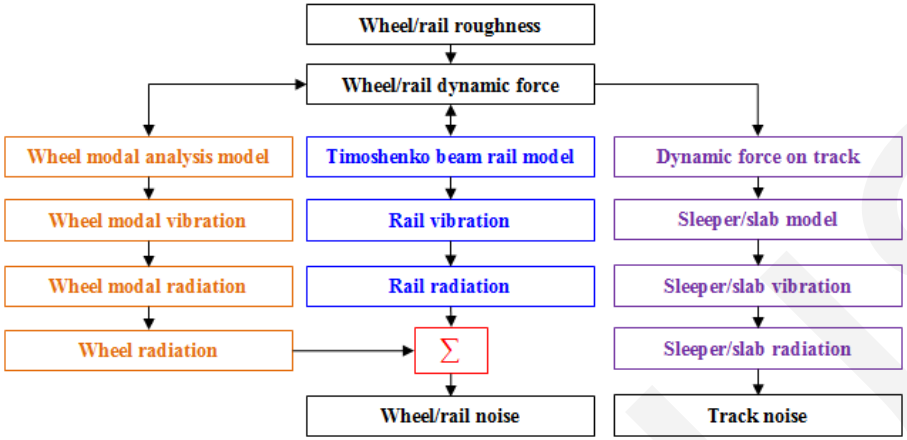

Fig. 6 Wheel/rail noise prediction using the HWTNS (Wu, 2012)

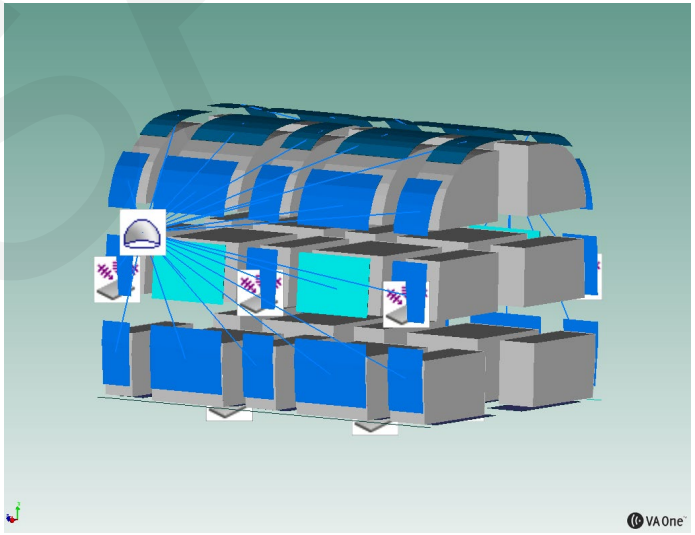

Fig. 9 The hybrid FE-SEA simulation model of coach end

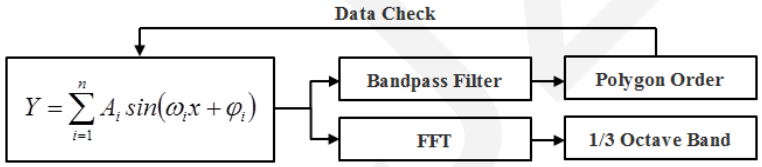

Fig. 11 The MATLAB code technique routine for creating wheel polygon data

Different Polygon Order

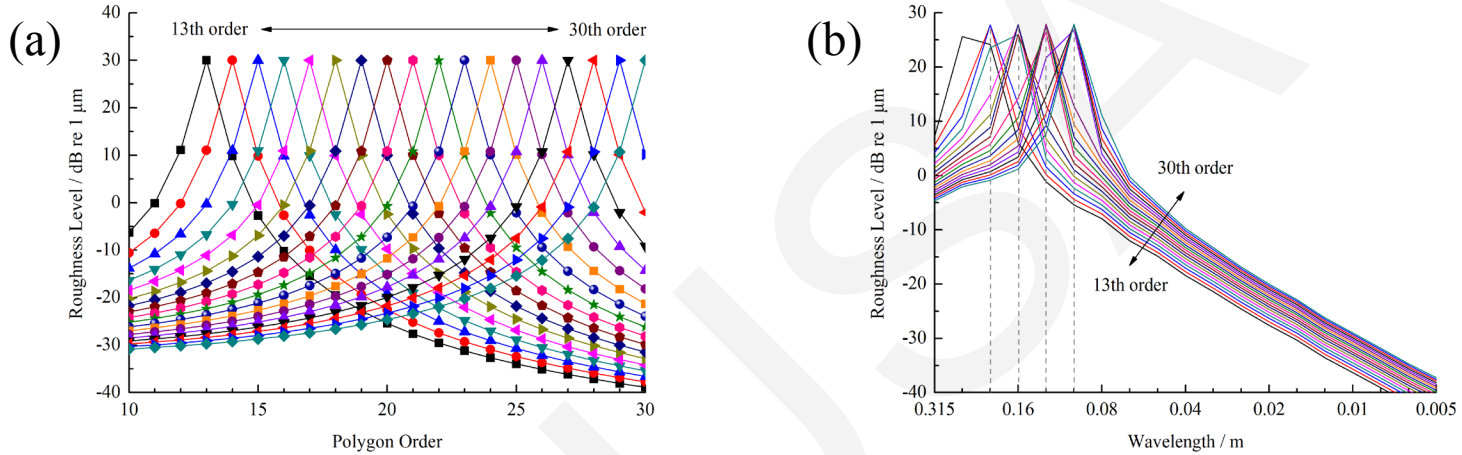

Fig. 12 Different polygon order: (a) polygon roughness levels characterized by order, (b) polygon roughness levels characterized with the wavelength

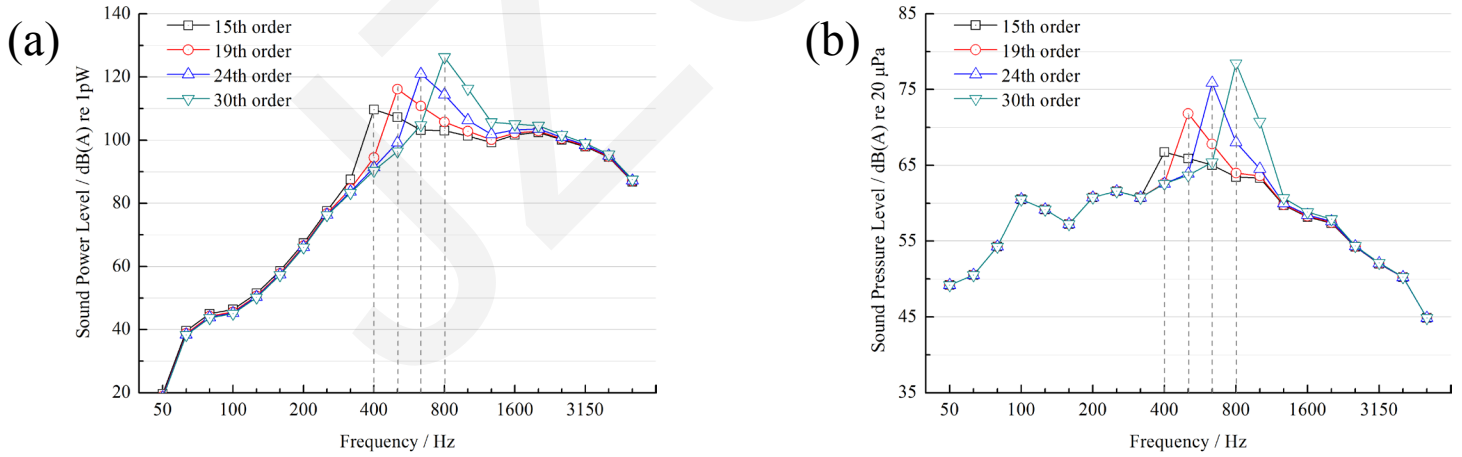

Fig. 13 Different polygon order: (a) wheel/rail noise, (b) interior noise.

Different Roughness Levels

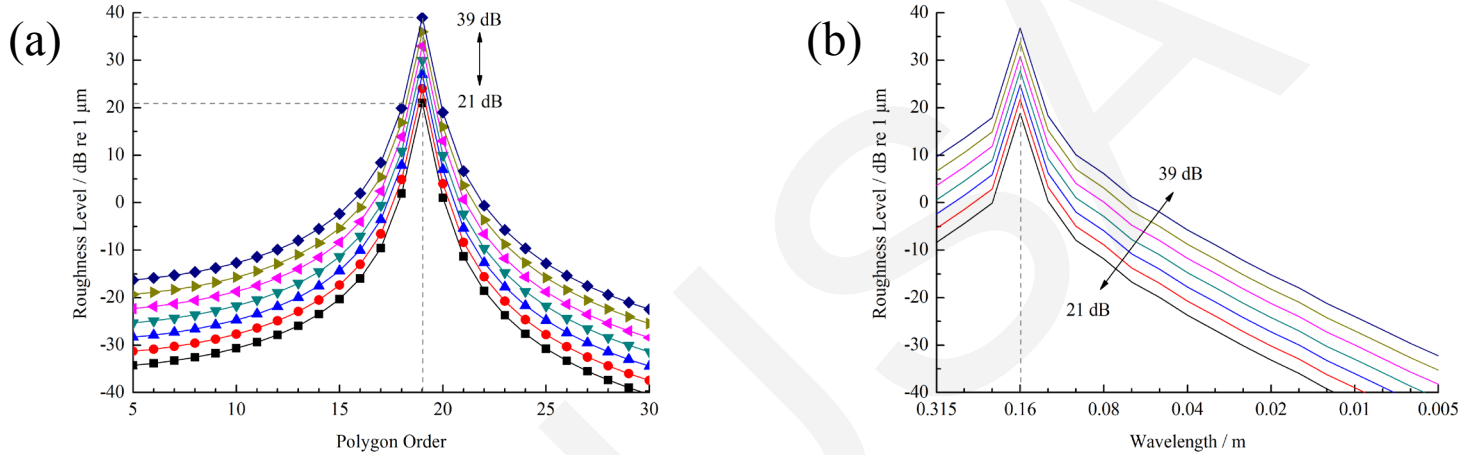

Fig. 14 Different roughness levels: (a) polygon roughness levels characterized by order, (b) polygon roughness levels characterized with the wavelength

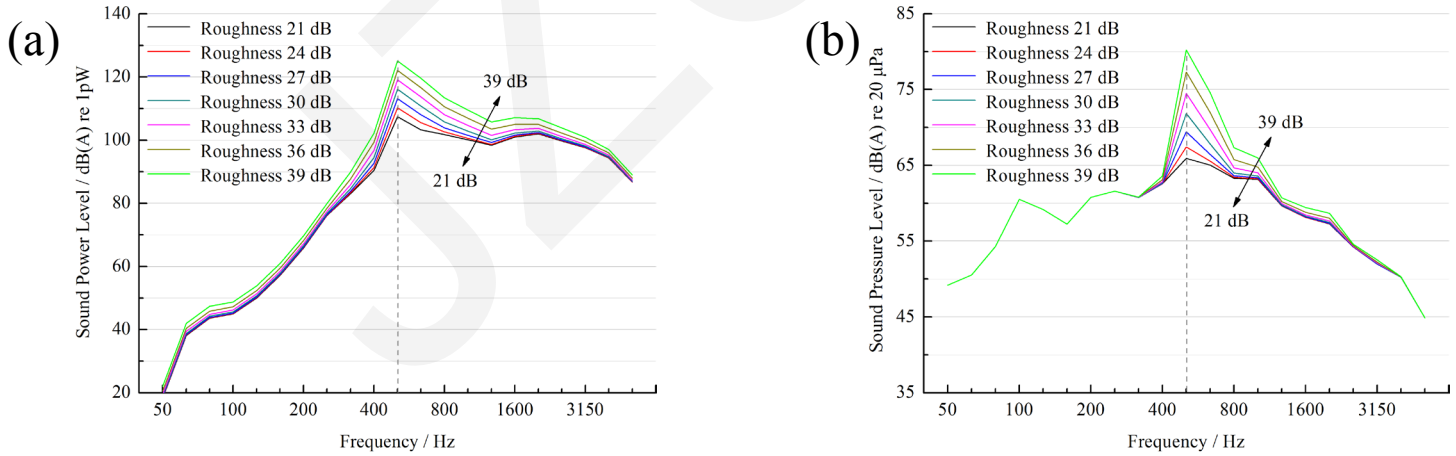

Fig. 15 Different roughness levels: (a) wheel/rail noise, (b) interior noise.

Different Polygon Phases

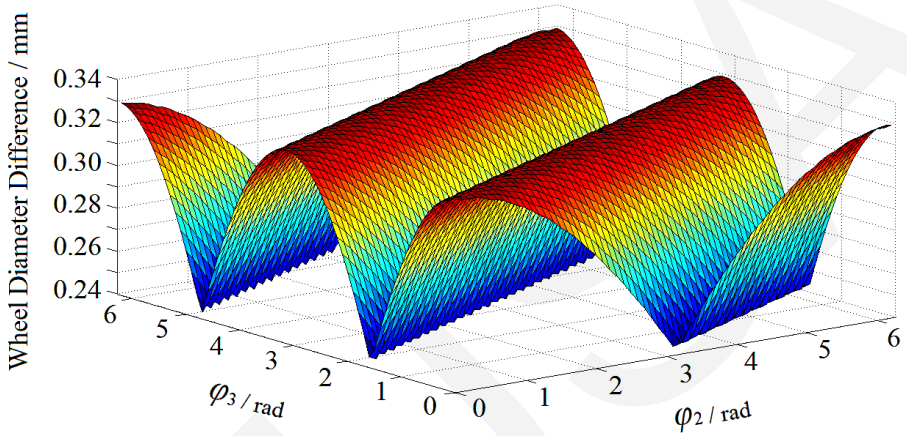

Fig. 16 Wheel diameter differences caused by combination of different phase angles

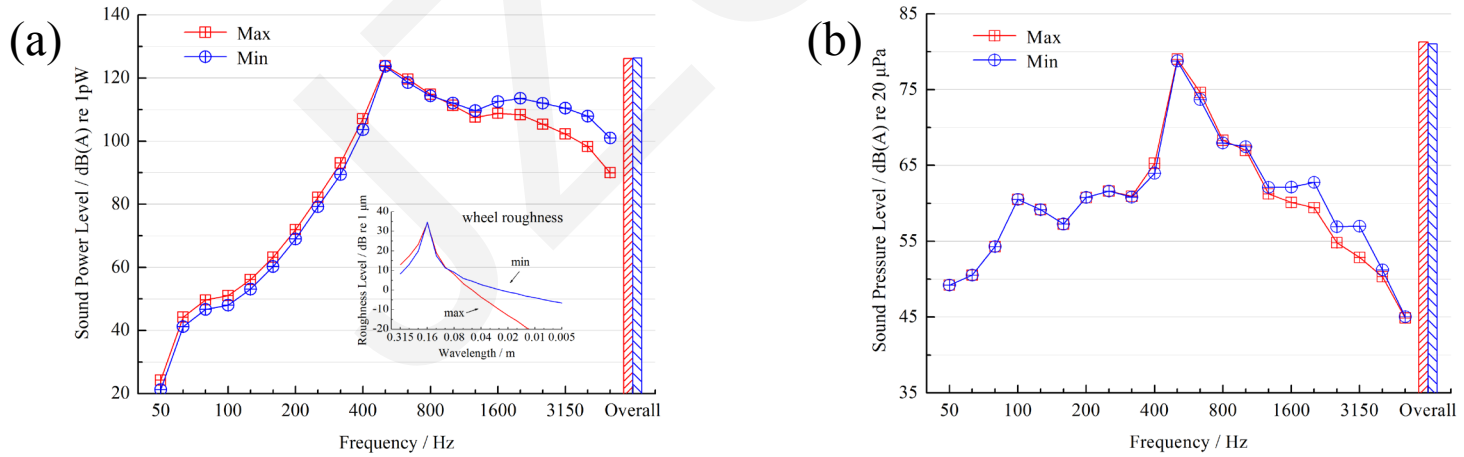

Fig. 17 Different roughness levels: (a) wheel/rail noise, (b) interior noise.

Conclusions

- Through test and simulation, in cases where the wheel circle diameter differences due to the wheel polygonal wear are nearly the same, the different wheel polygonal wear patterns can cause different wheel/rail noise levels.
- The numerical simulation shows that the different polygon order with nearly the same roughness levels can cause different wheel/rail noise levels and interior noise levels. Namely, the wheel polygons with higher order can make more serious wheel/rail noise and interior noise. This is because the higher order has the higher passing frequency at a certain operational speed, and generates higher wheel/rail vibration energy.
- Changing the phases or the distribution of the wheel polygons can change the wheel diameter difference caused by the wheel polygonal wear. However, the effect of the change of the polygon phases is not great on wheel/rail noise and interior noise.