

# Finite element model updating methodology and application to flexible resonance of high-speed railway vehicles

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# Complex High-Speed Train Carbody In Service

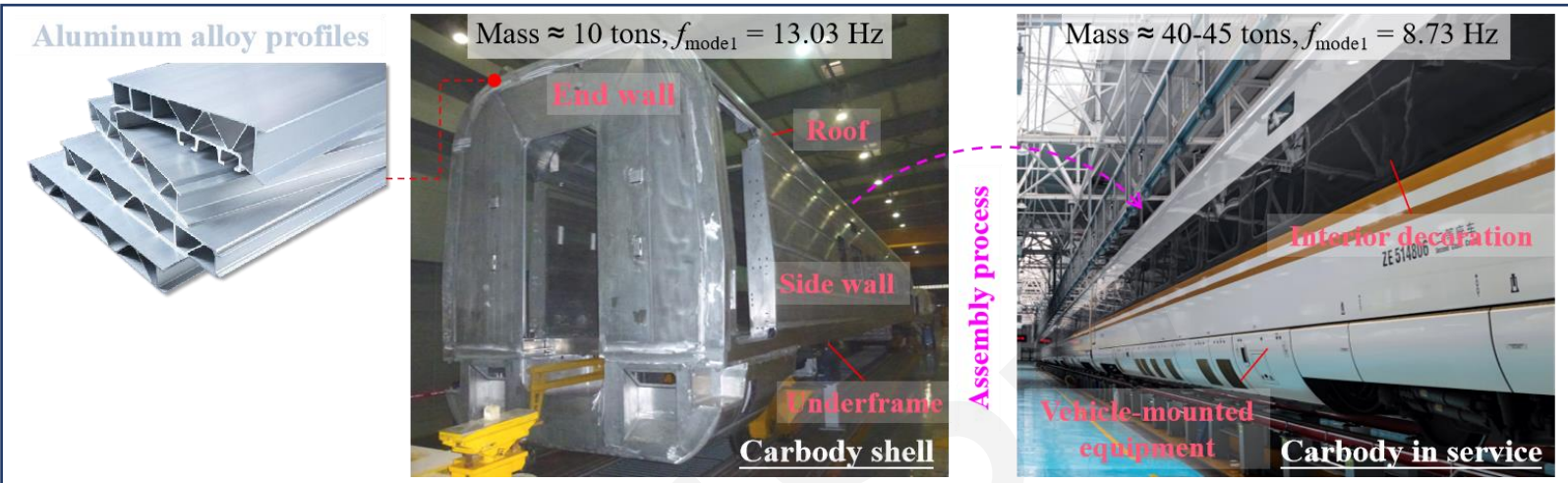


Fig. 1 Difference in appearance between the carbody shell and the carbody in service

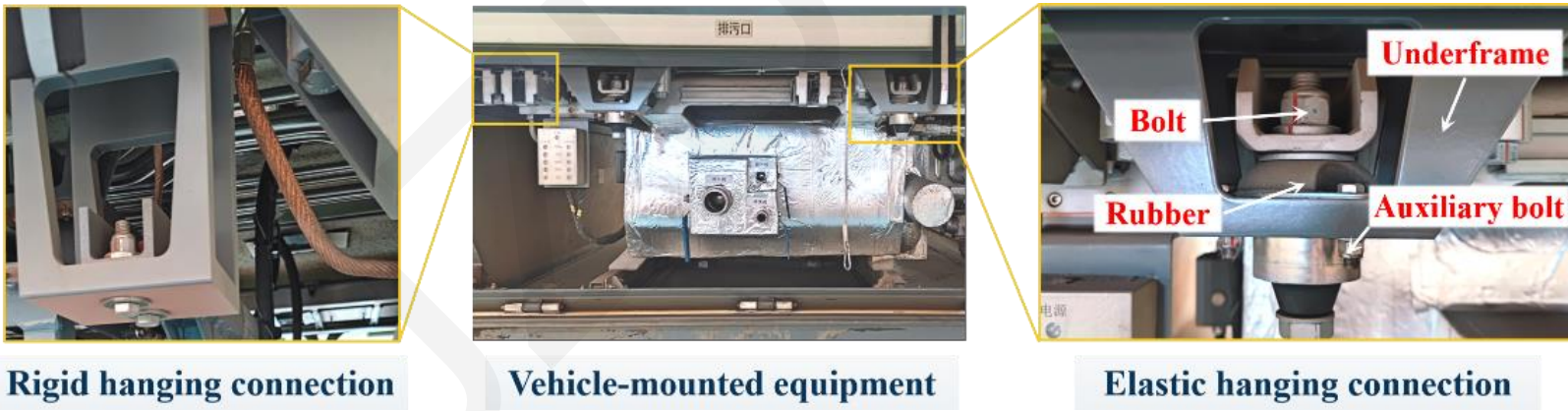
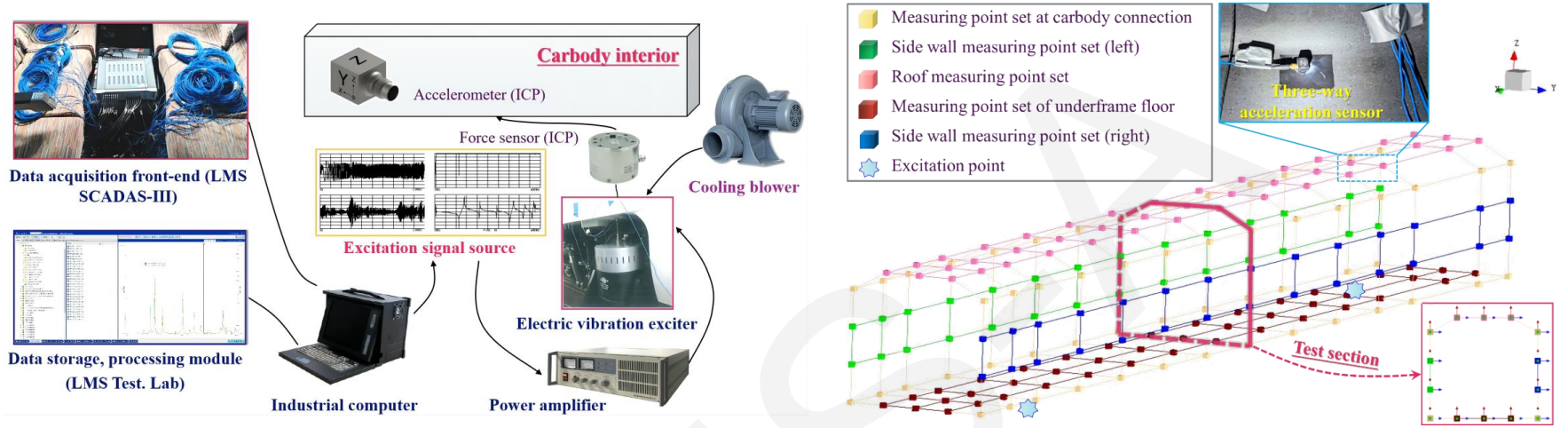


Fig. 2 Equipment under the carbody underframe: Elastic hanging and rigid hanging connection

# Carbody Modal Test



The flowchart of the carbody modal test

Layout of measuring points

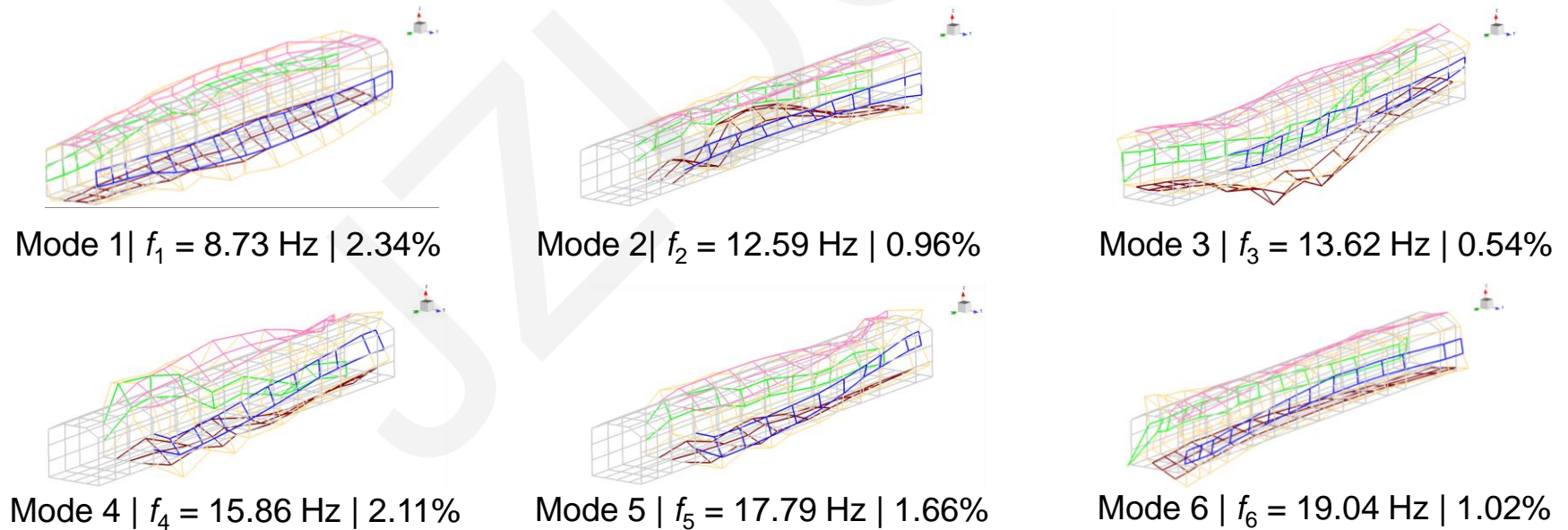
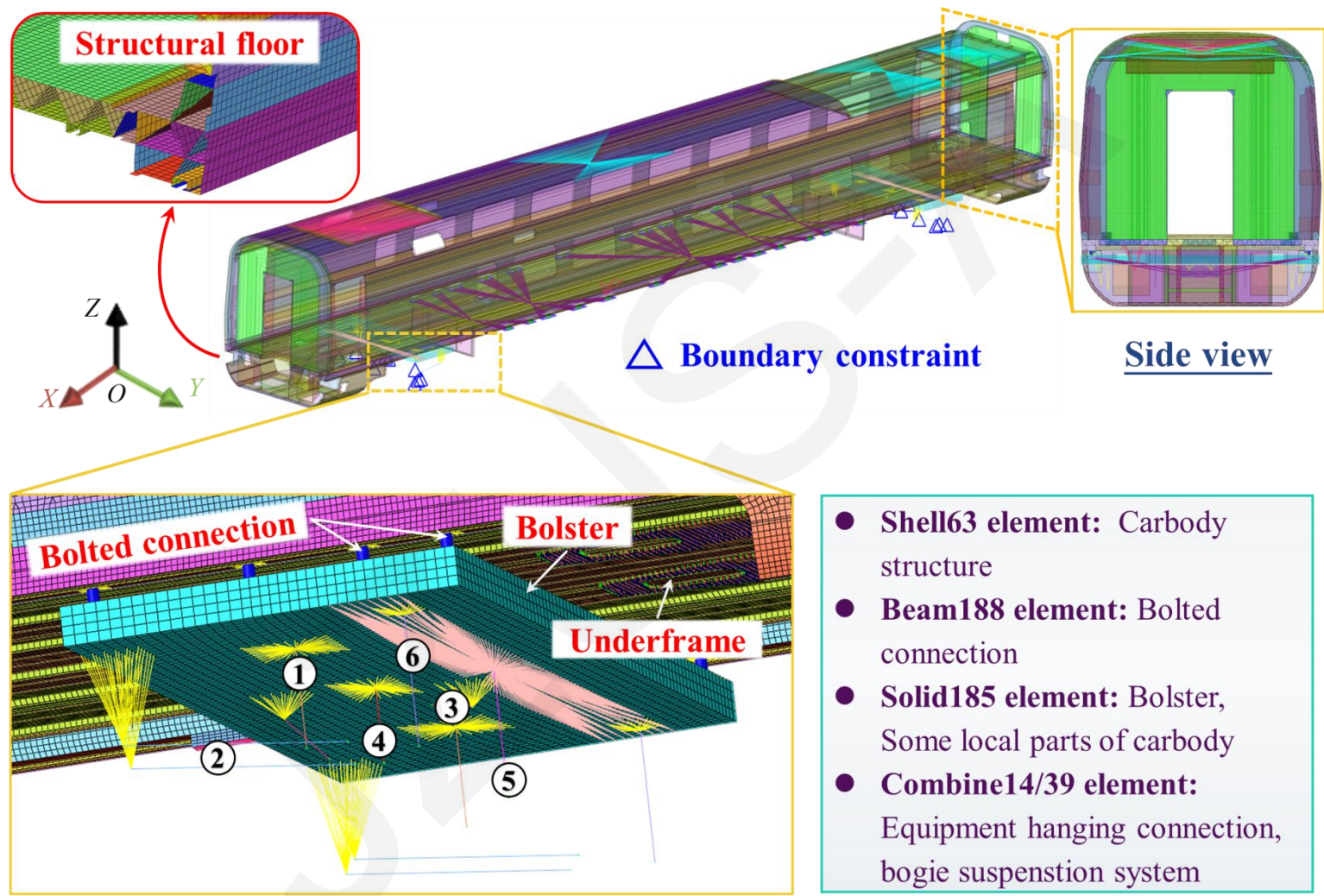


Fig. 3 Experimental modal parameters of the carbody

# FE modeling of Carbody



1-Air spring, 2-Anti-yaw damper, 3-Secondary lateral damper, 4-Traction rod, 5-Anti-rolling torsion bar, 6-Secondary vertical damper

**Fig. 4 Carbody FE model in operational service**

# Model Updating Methodology

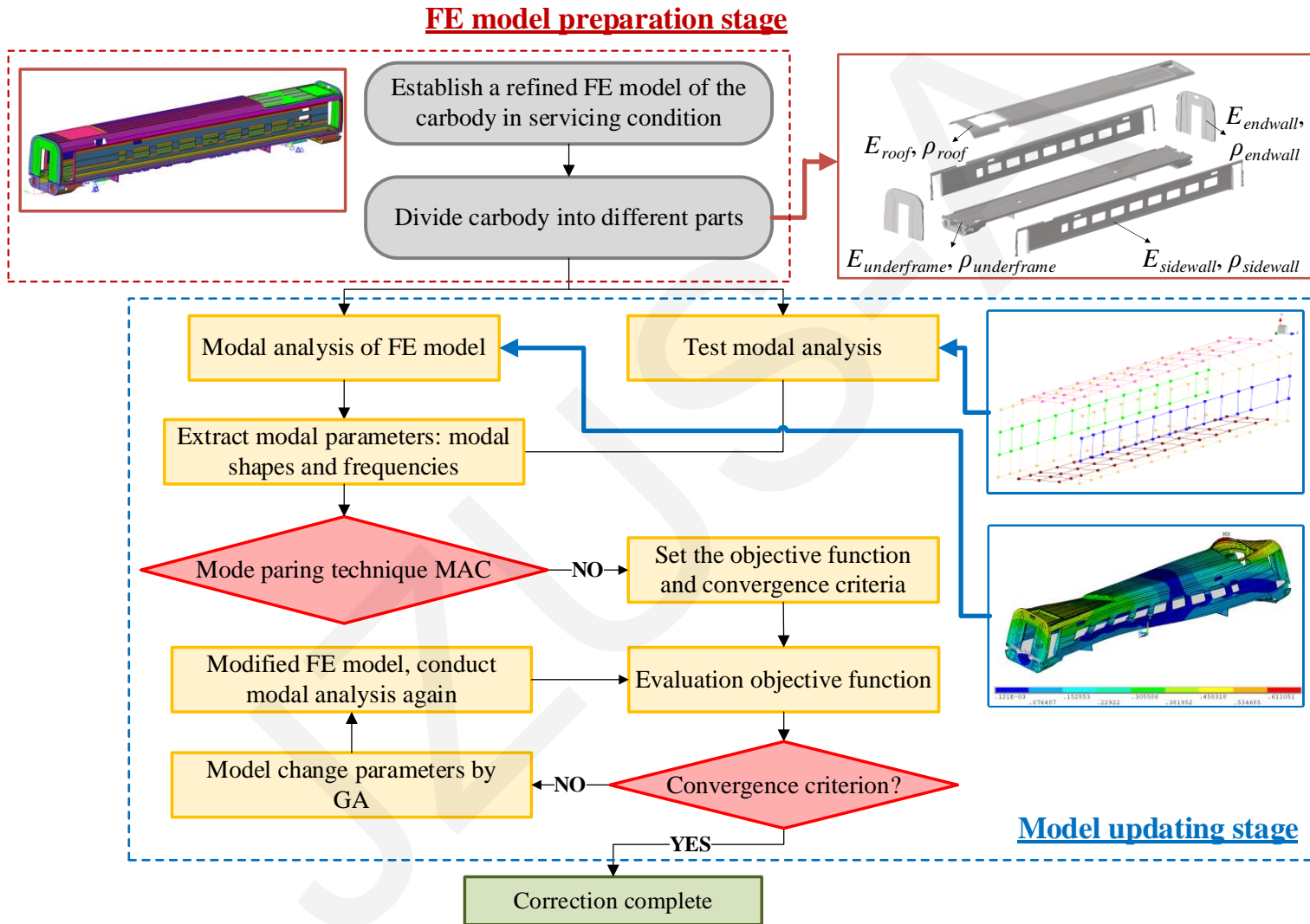
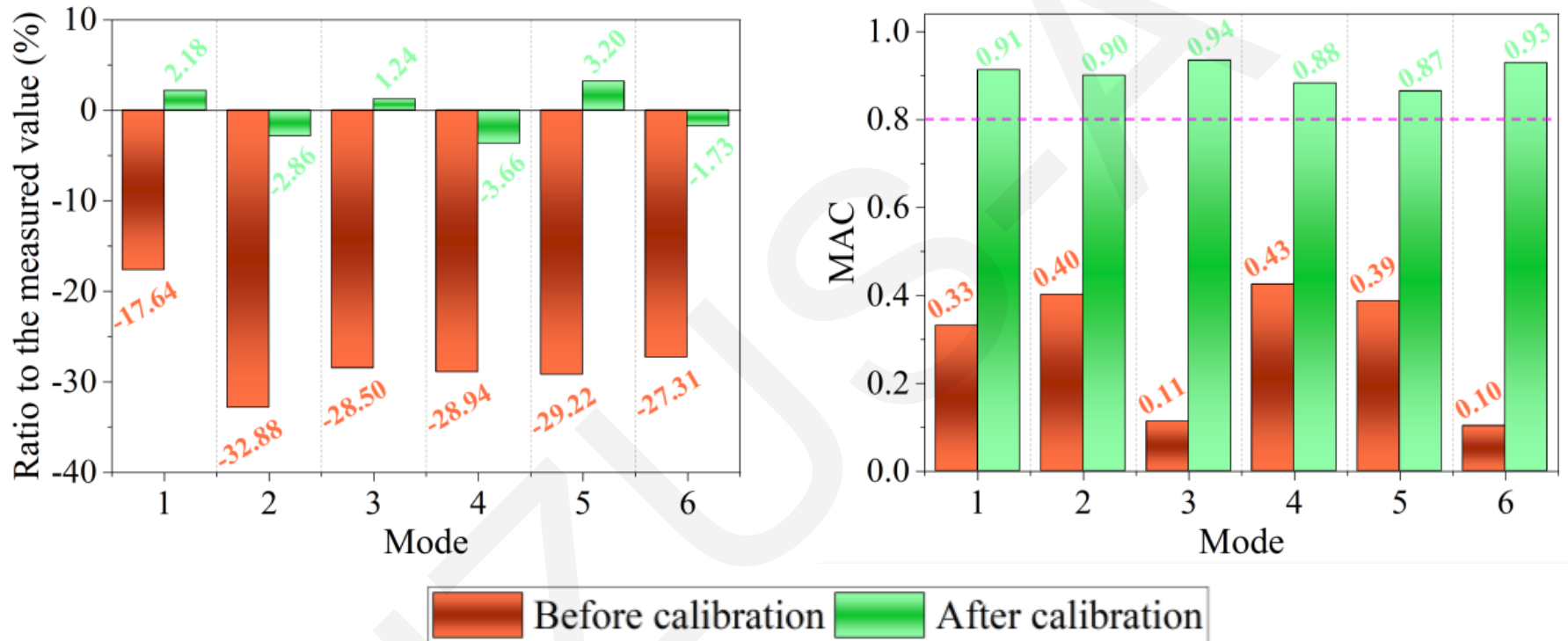


Fig. 5 The carbody FE model updating process used in this study

# Experimental Verification



**Fig. 6** Errors between experimental and numerical modal responses, before and after calibration: Natural frequencies and MAC indicator

# Application in the flexible resonance

## High-speed Train Vehicle-Track Coupled Model

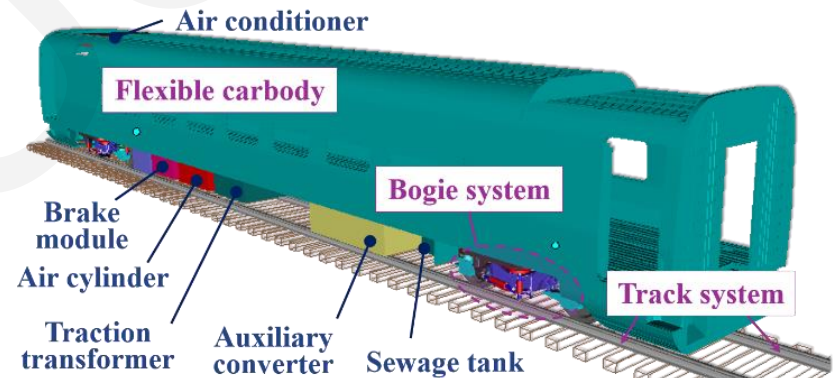
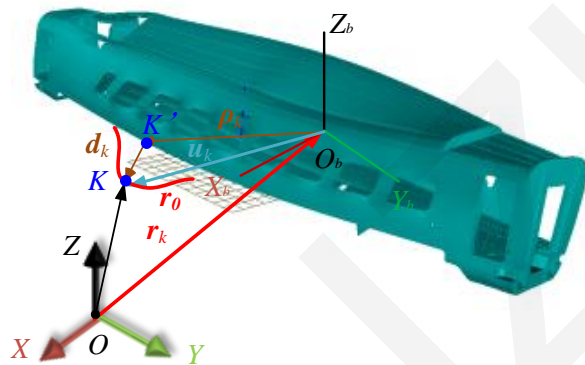
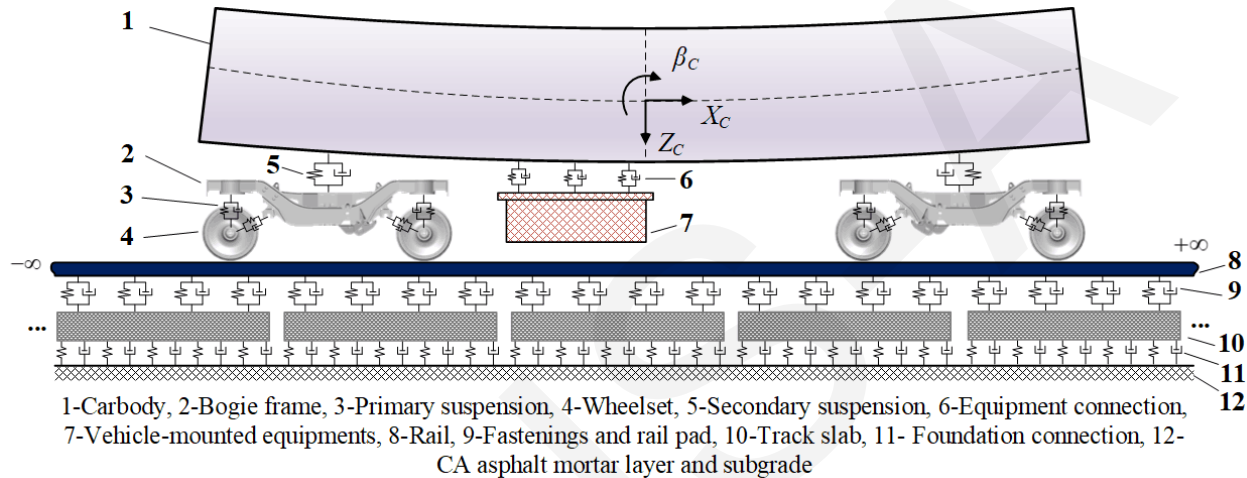
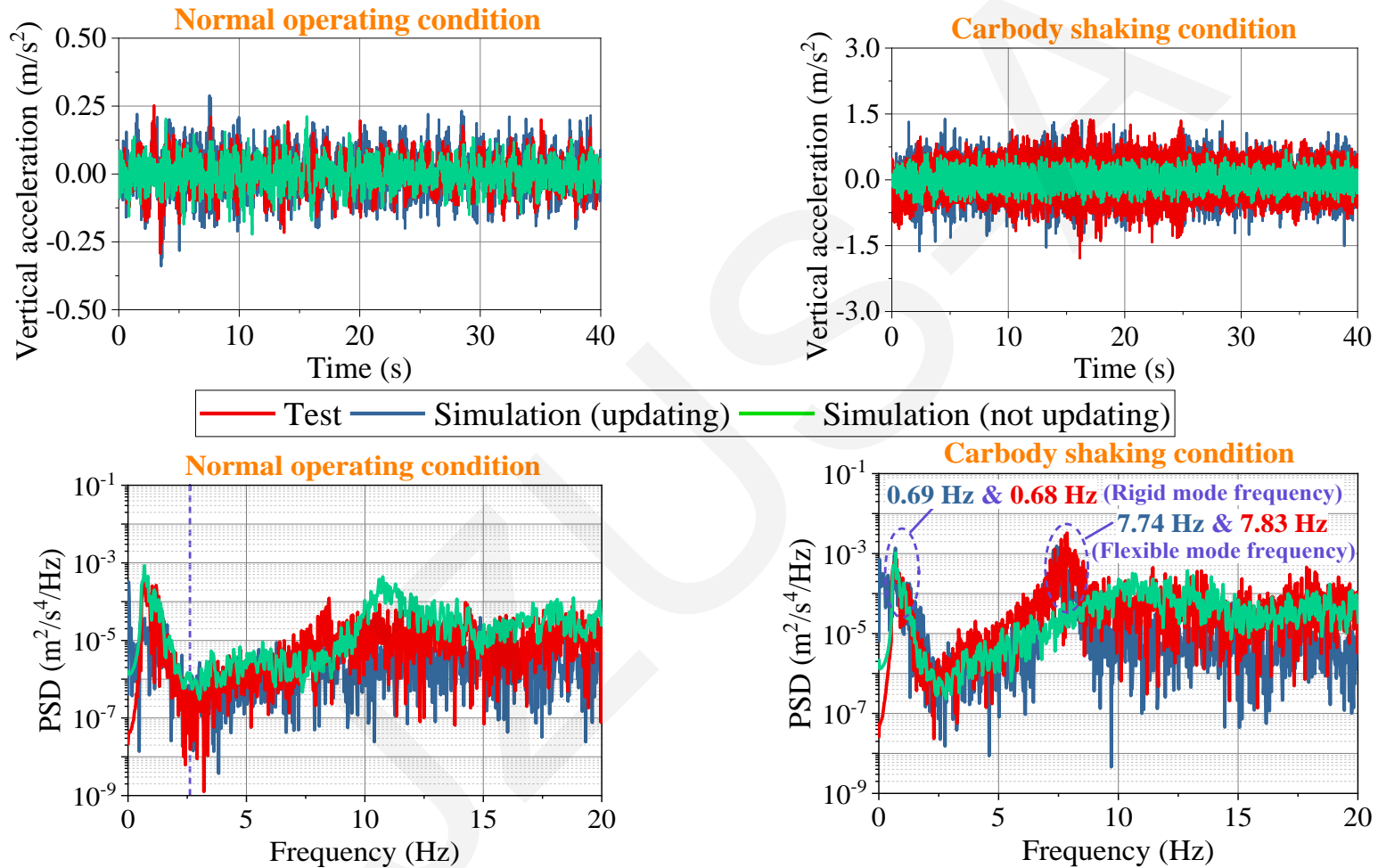


Fig. 7 Schematic view of the high-speed vehicle-track coupled dynamics model: (a) Layout of high-speed railway vehicle multibody dynamics model with flexible carbody; (b) Floating reference frame for the carbody; (c) Dynamic simulation model established in Universal Mechanism.

# Application in the flexible resonance

## Simulation difference before and after updating



**Fig. 8** Time histories and PSD diagrams of carbody middle floor accelerations under simulation (before and after updating) and test (350 km/h)

# Conclusions

- The proposed correction method based on EMA and GA can effectively eliminate model errors.
- The material parameters of the in-service carbody differ significantly from those of the original aluminum alloy.
- The updated model can accurately predict abnormal vibrations of the carbody.