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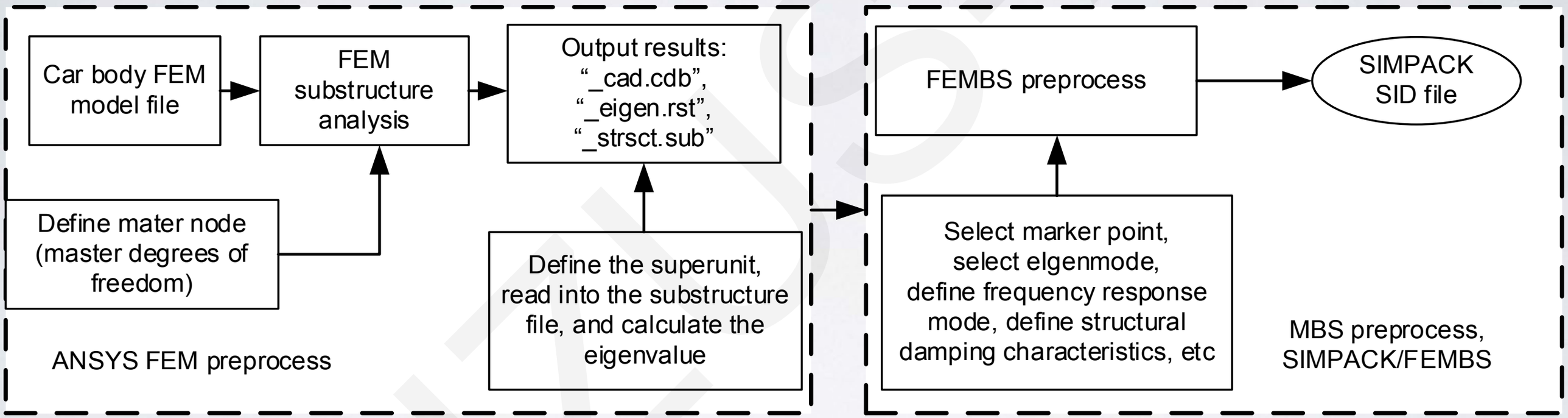
Test technology research and fatigue damage prediction of a car body based on dynamic simulation load spectrum

Key words:

dynamic model, car body, load time history, fatigue, damage

General Idea

- Rigid-flexible Coupled Multibody System Dynamics Modeling



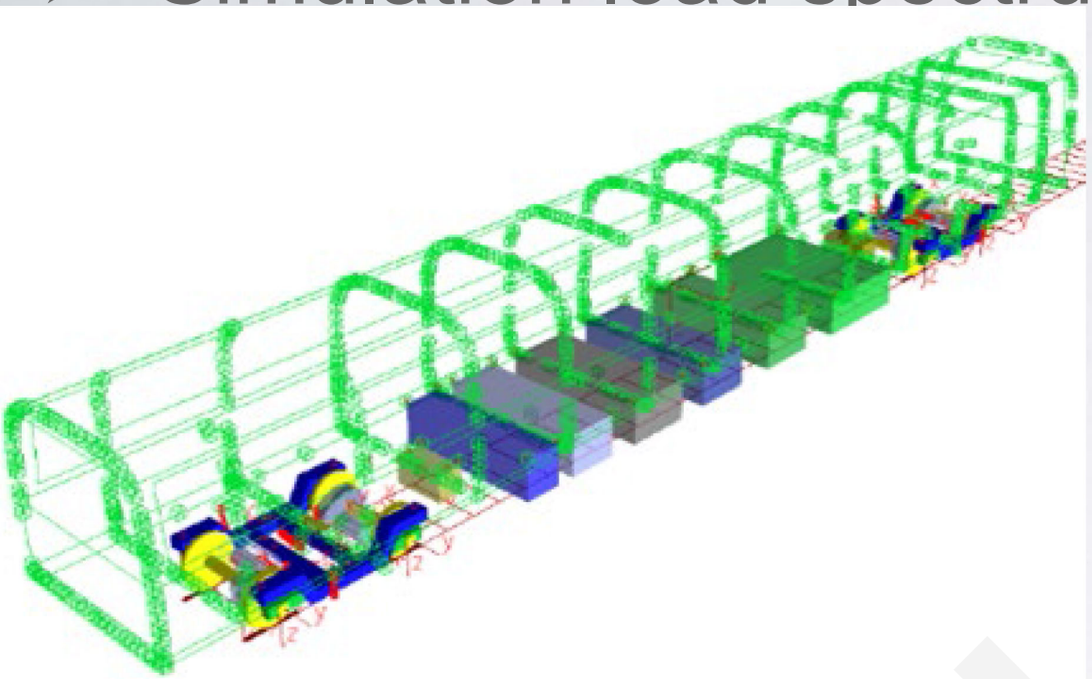
General Idea

➢ Dynamics Simulation Case Settings

Normal Cases	Cases 1（straight line）	Speed rating： 100、150、200、250、300、350、400km/h
	Cases 2（curve）	Speed rating： 100、150、200、250、300、350km/h
	Cases 3（turnout）	Speed rating： 100、150、200、220km/h
	Cases 4（twist）	Speed rating： 20、30、40、50km/h
	Cases 5 （traction）	Speed rating： 100、150、200、250、300、350km/h
Fault Cases	Cases 6（air spring failure）	Speed rating： 100、150、200、250、300、350 km/h
	Cases 7（secondary vertical damper failure）	Speed rating： 100、150、200、250、300、350 km/h
	Cases 8（lateral damper failure）	Speed rating： 100、150、200、250km/h
	Cases 9（anti-hunting damper failure）	Speed rating： 100、150、200、250km/h

General Idea

- Simulation load spectrum analysis



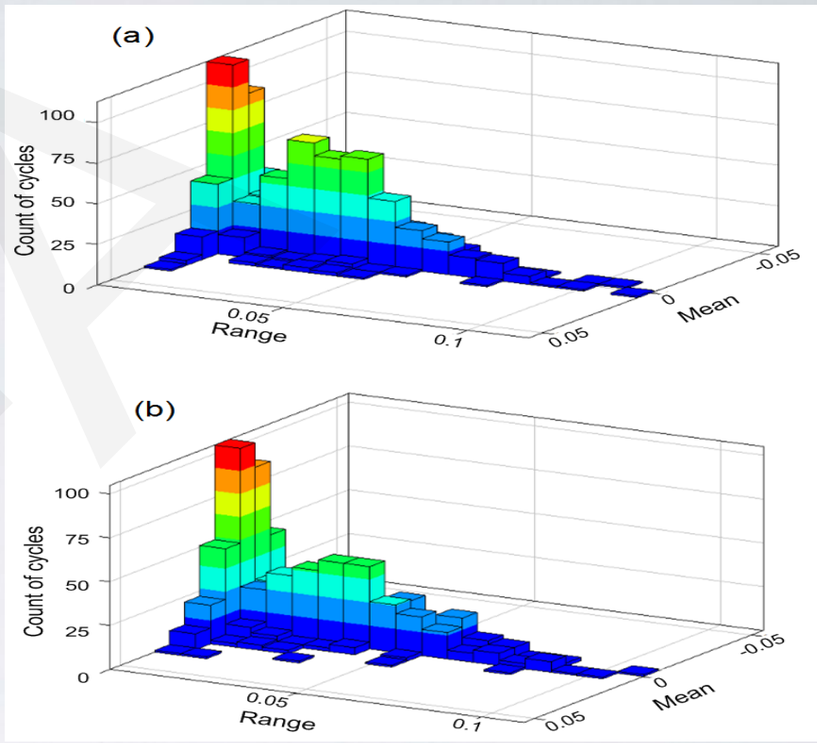


Fig. 4 Rain flow histogram for a_x of 350-km/h (a) an
400-km/h (b) car body in a straight line

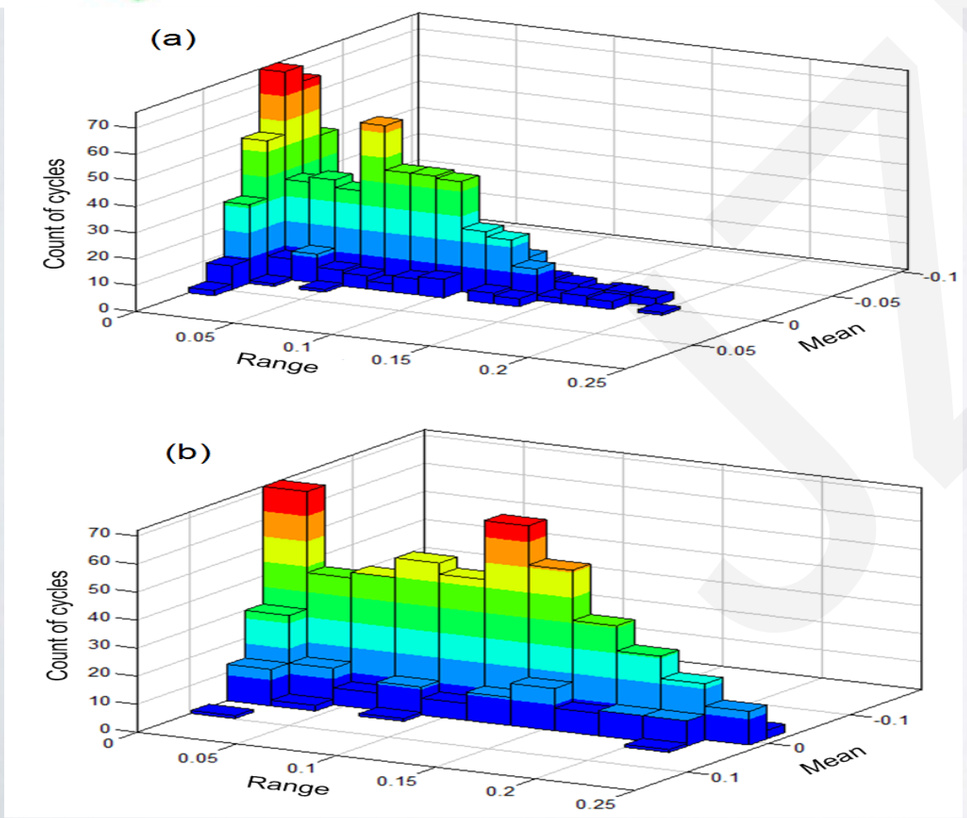


Fig. 5 Rain flow histogram for a_y of 350-km/h (a) and 400-km/h (b) car body in a straight line

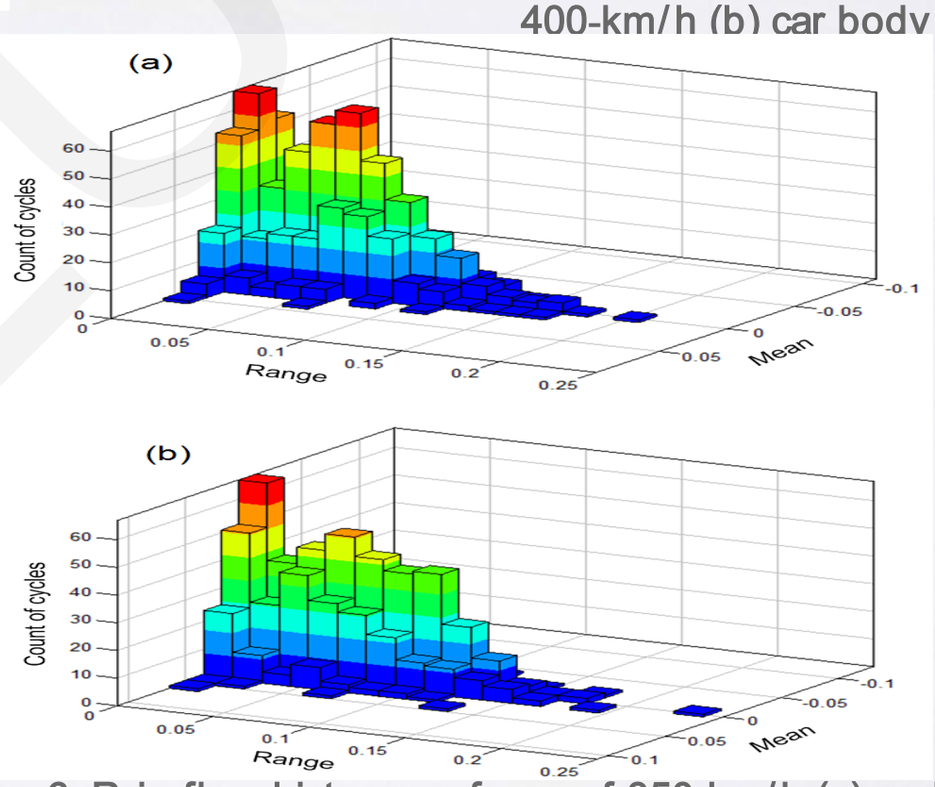
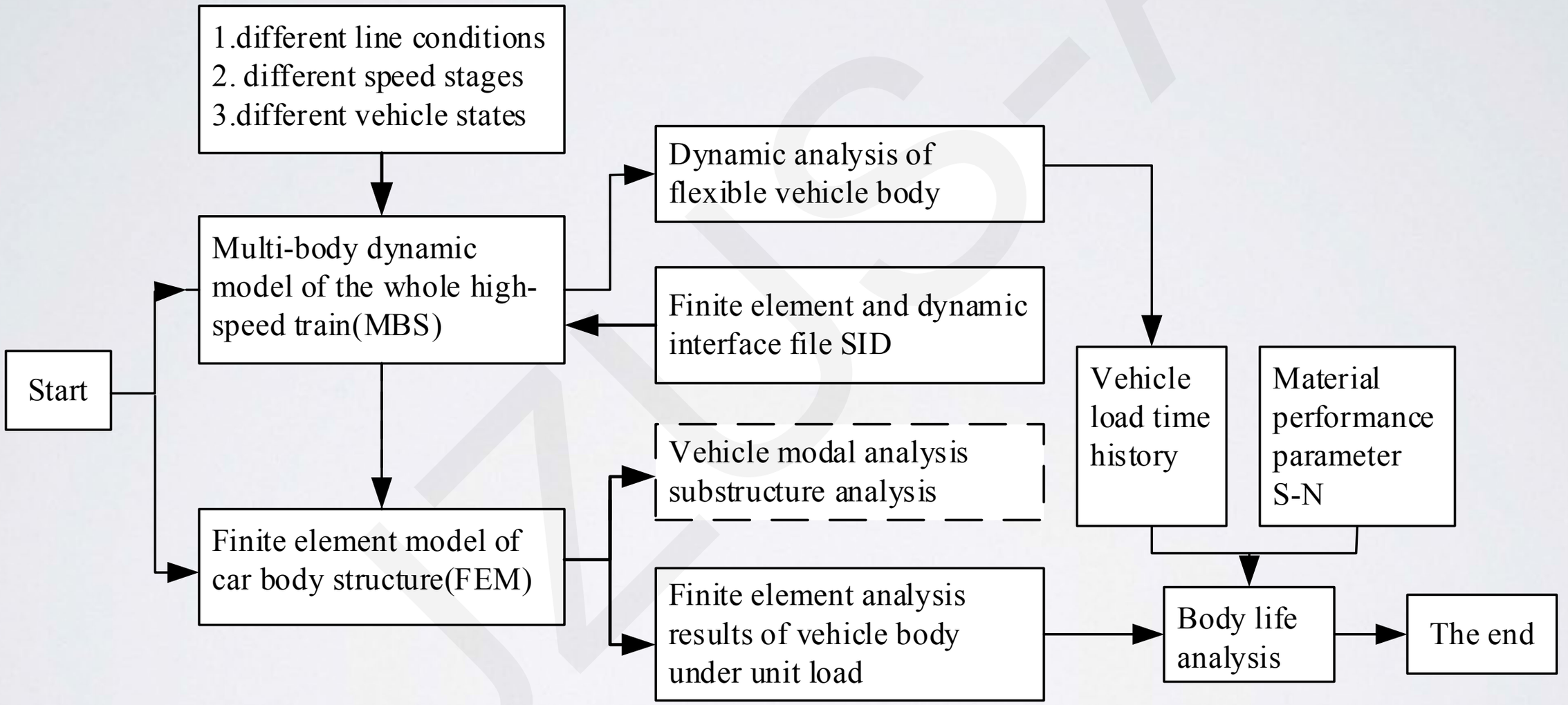


Fig. 6 Rain flow histogram for a_z of 350-km/h (a) and 400-

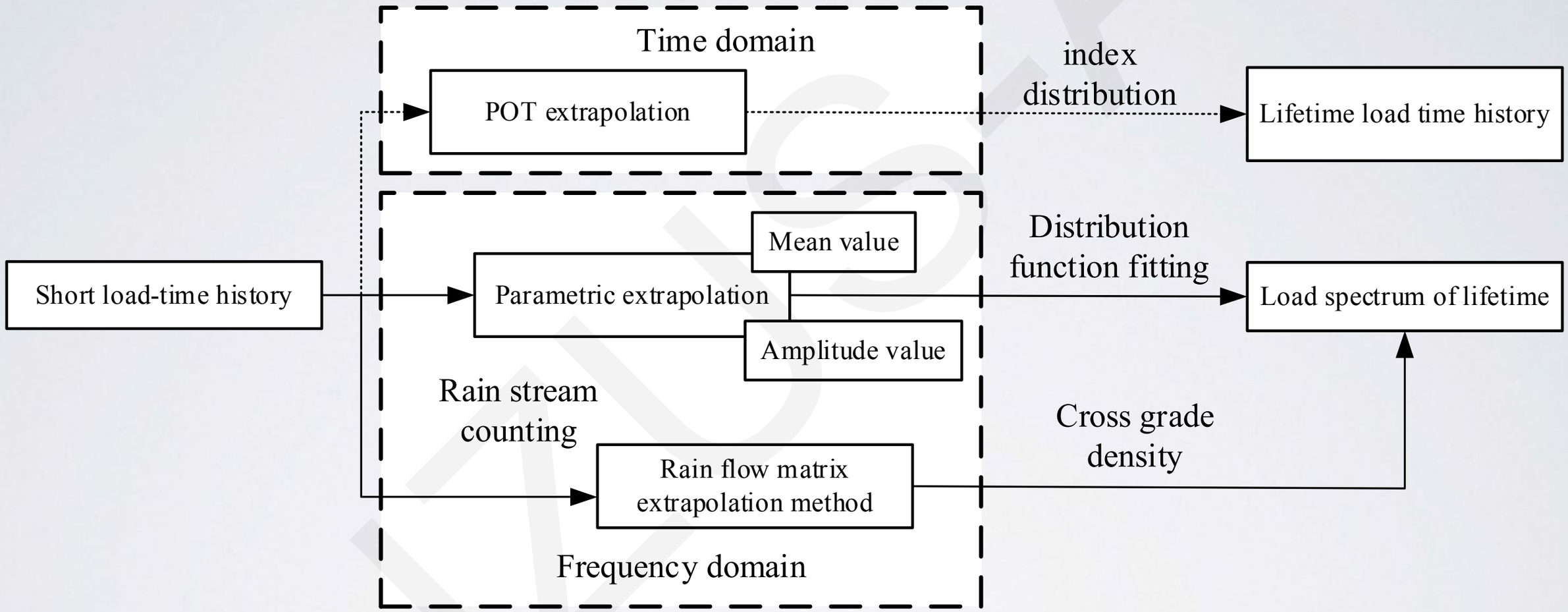
General Idea

- Fatigue-life assessment of car body structure



General Idea

- Preparation of vehicle fatigue load spectrum



Conclusions

- It is found that the acceleration of the three directions of the vehicle body increases with the increase of speed. When the train passes a curve, it will cause the lateral acceleration to be larger. The passage of a turnout or twisted line will cause the acceleration of the car body to increase in three directions. With an empty spring failure, the vertical acceleration of the car body will increase significantly. Failure of the anti-yaw damper will cause a significant increase in the lateral acceleration of the car body and failure of the secondary lateral and vertical dampers will cause an increase in acceleration in three directions, but the increase is not obvious. The acceleration of the car body increases for wear-type tread under different conditions and speed levels relative to the original tread.
- The results show that vehicle body damage increases with increased speed and the wear type tread exhibits that more than the non-wearing type. Considering significant damage to the car body, it is found that, under fault conditions, when the speed is low (v<200km/h), the failure of the air spring causes significant damage to the car body but other conditions are not harmful to it; when the speed is v> 200km/h, failure of the anti-yaw damper failure causes the greatest damage to the car body. When the train passes through a turnout and or twisted line, it will also cause certain damage to the car body but, because the speed is lower when passing through these areas, the impact is not very large. When the train is subjected to traction braking, the damage increases as the speed is increases. When the traction speed reaches 300 km/h or more, the damage increases sharply.

- We introduce the vehicle body load spectrum processing method, and finally take 5% of the maximum value of the load as the invalid amplitude, and the parameters are fitted according to the distribution shape of the mean value and the amplitude value, and the extreme value is determined. A standard 8-level load spectrum suitable for the vehicle body fatigue test was prepared, and the vehicle body was subjected to a fatigue test of 10 million times (It is repeated ten times to the standard load block spectrum) on the vehicle body fatigue test bench.