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Numerical model and multi-objective optimization analysis of vehicle vibration

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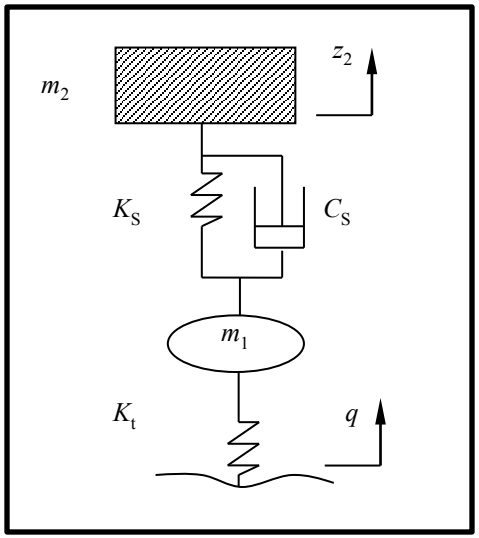
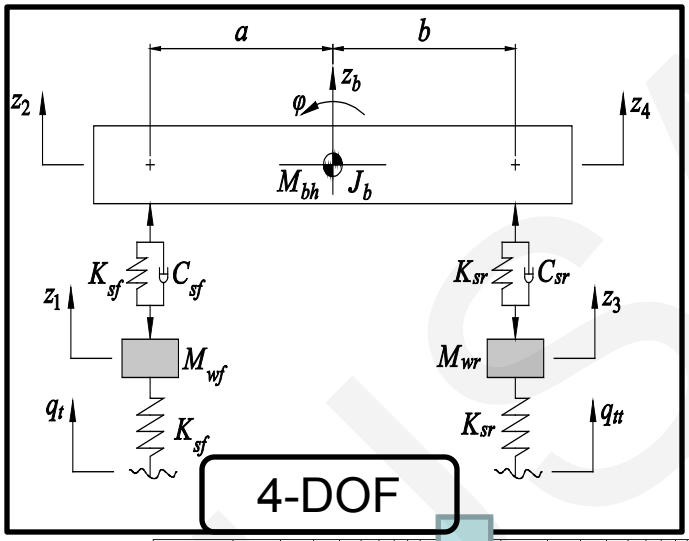
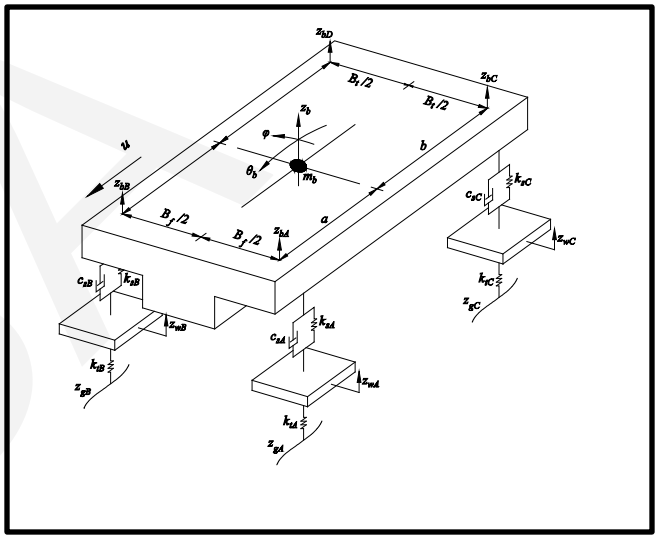
Vehicle model and road dynamics



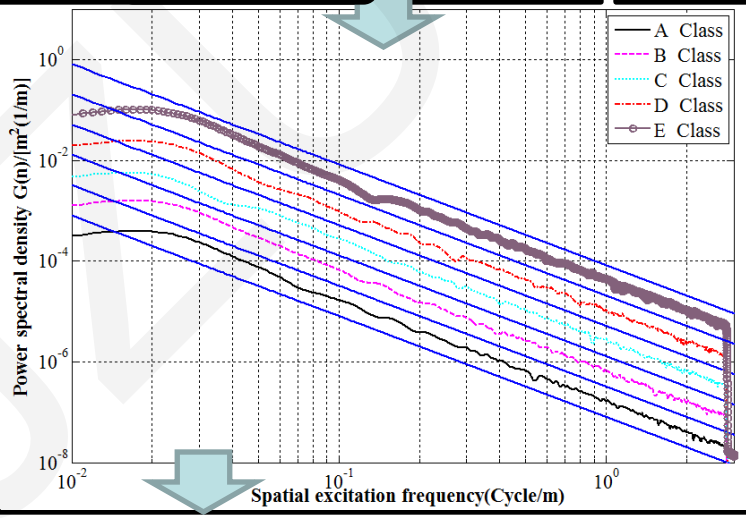
2-DOF



4-DOF



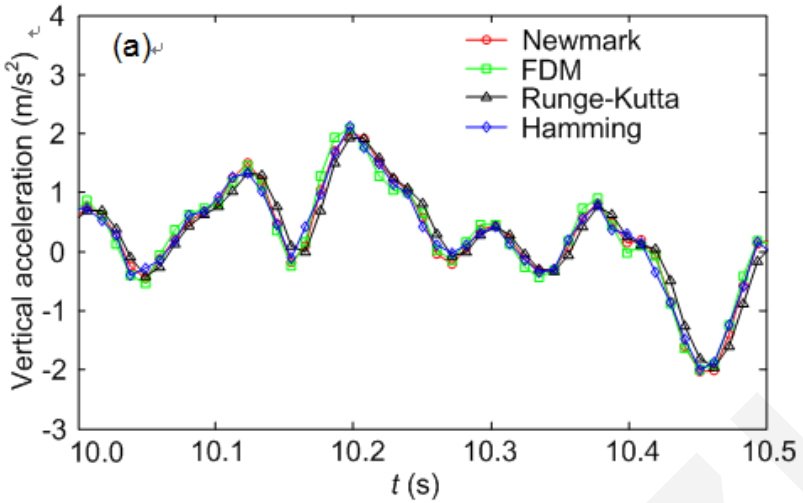
7-DOF

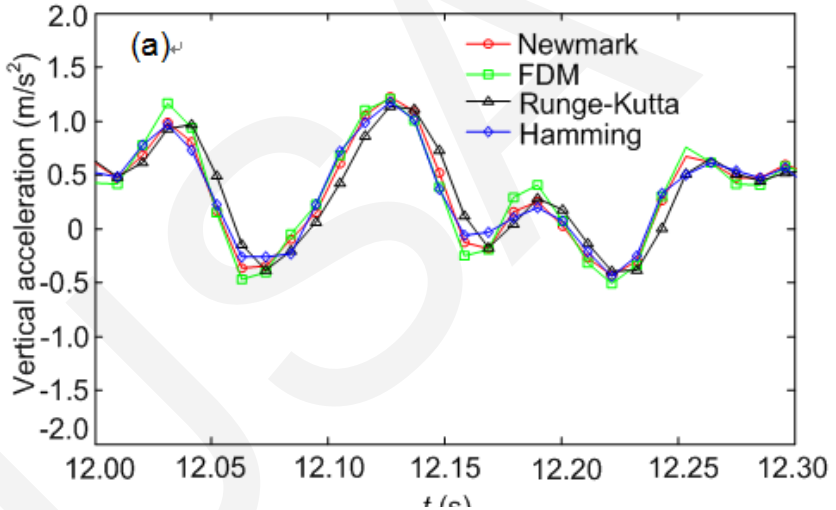


the road-vehicle coupling dynamics model and the performance indices are discussed, such as ride comfort, the energy, and road handing

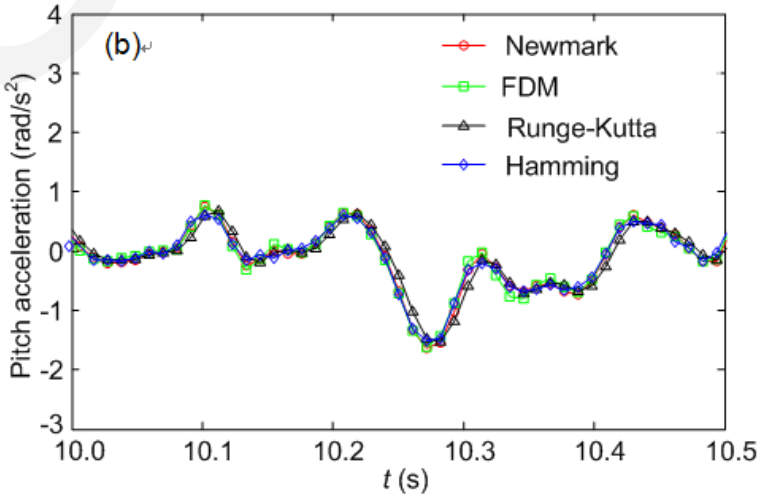
The characteristics comparison under different model

4-DOF → 7-DOF

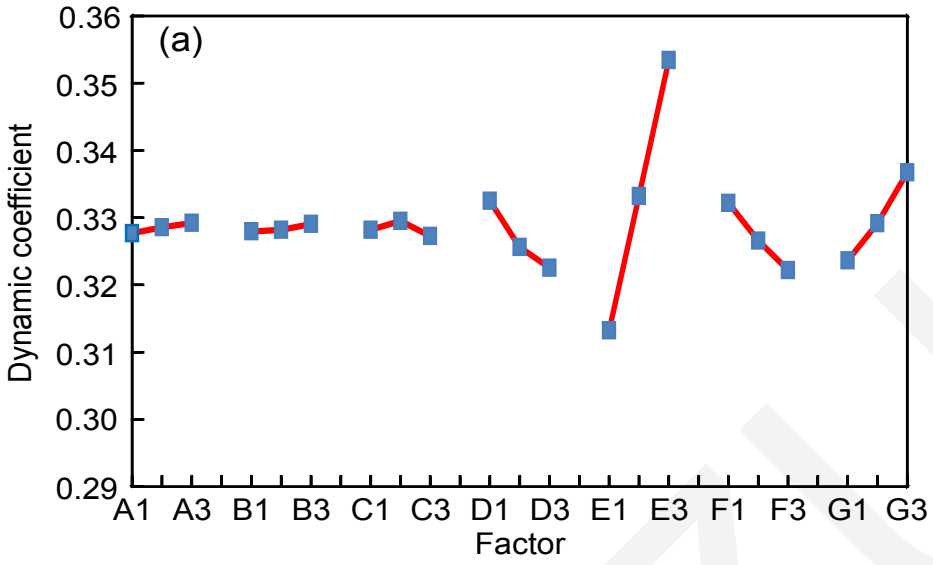


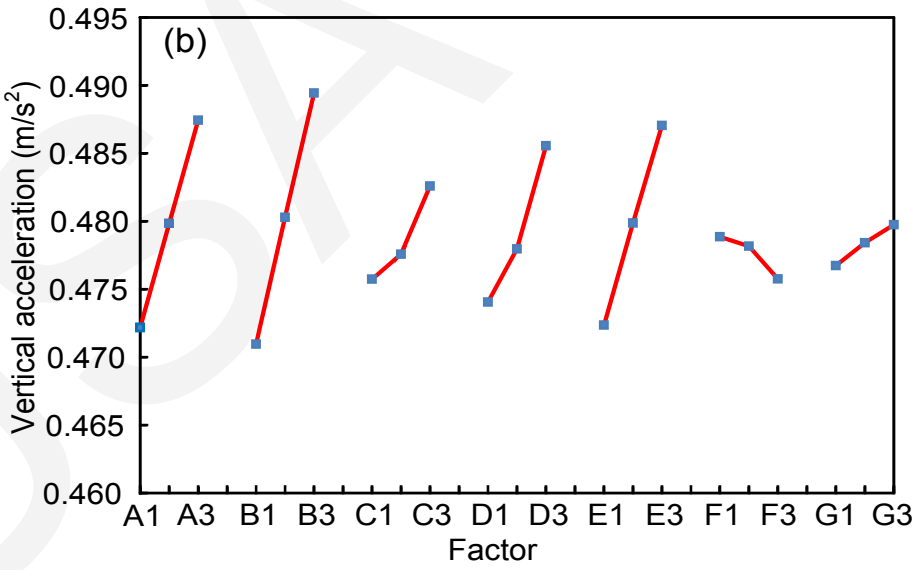


Comparison of vertical acceleration and pitch acceleration among different methods



DOE analysis for the vehicle characteristics





The effect the aforementioned seven factors on the dynamic load coefficient can be arranged according to the DOE, Pareto effect of all the parameters are also carried out

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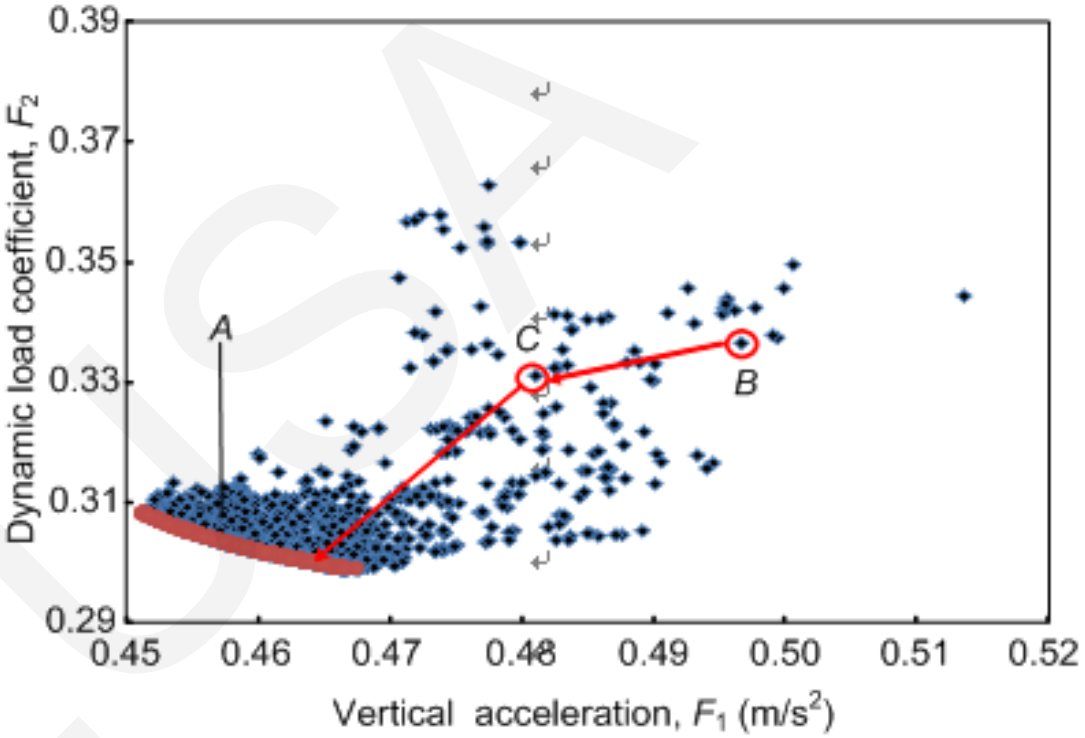
Optimization analysis

$$F_1 = \sqrt{\frac{1}{N}\sum_{t=1}^{N}\left|\ddot{z}_b\right|^2}$$

$$F_2 = \sqrt{\frac{1}{N}\sum_{t=1}^{N}\left|\frac{\frac{F_{d1}(t)}{G_1}+\frac{F_{d2}(t)}{G_2}+\frac{F_{d3}(t)}{G_3}+\frac{F_{d4}(t)}{G_4}}{4}\right|^2}$$



After the optimization analysis, the results showed that the optimal results were not always the only results; there are many optimized results in the multi-objective optimization analysis and these results form a set. They move to a small region after the calculation and form an edge, which is called a Pareto edge.

F_1 reduces by 7.22%, F_2 reduces by 6.82%

Conclusions

1.The Runge-Kutta method was better than the four-step Hamming method.The Hamming method calls former steps. An error exists at every step, which leads to the RMS being larger than that for the Runge-Kutta method, but this does not affect precision.

2.The effect of the weight of the aforementioned six factors on the dynamic load coefficient can be arranged. the interaction effect sometimes has a greater effect on the vehicle's dynamic behavior, and these effects are always neglected.

3.In a practical design, it is better to couple the DOE with the multi-objective optimization method to perform the optimization, which can avoid trapping in a local minimum or maximum, because the sample can distribute the entire space after the design of the experiment.