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Effects of accelerated loading on the stress response and rutting of pavements

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Experimental stress and strain measurements of asphalt pavement under APT loading

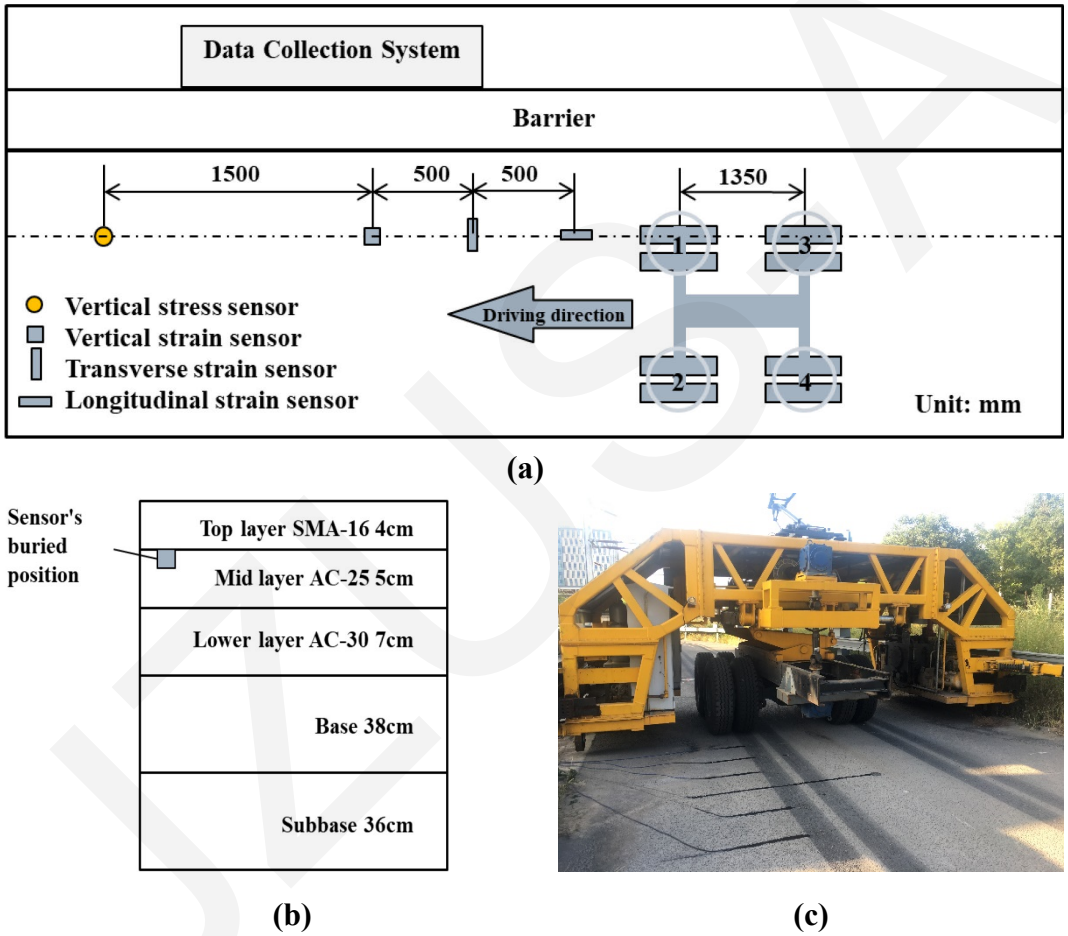


Fig. 1 Full scale test road under heavy load: (a) the layout of the test; (b) Sensor embedding depth; (c) Vehicle loading site

Experimental stress and strain measurements of asphalt pavement under APT loading

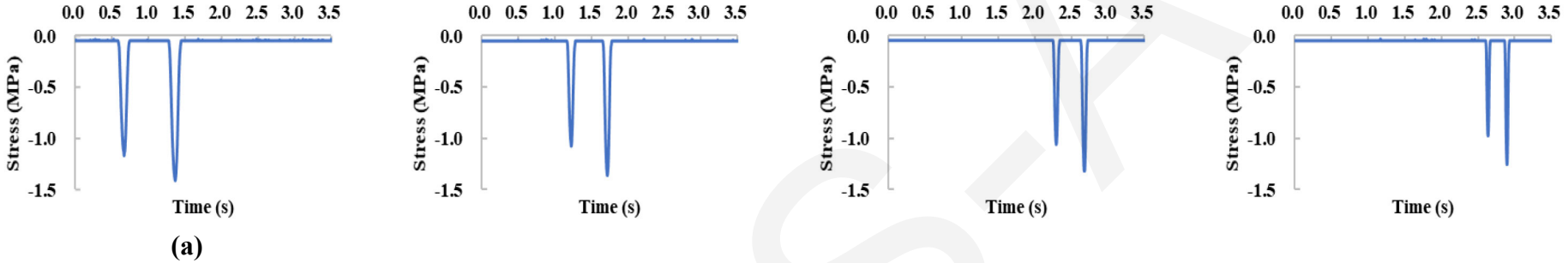


Fig. 2 Vertical stress curve at different speeds: (a) at 7.2 km/h ; (b) at 10.0 km/h; (c) at 12.6 km/h; (d) at 18.7 km/h

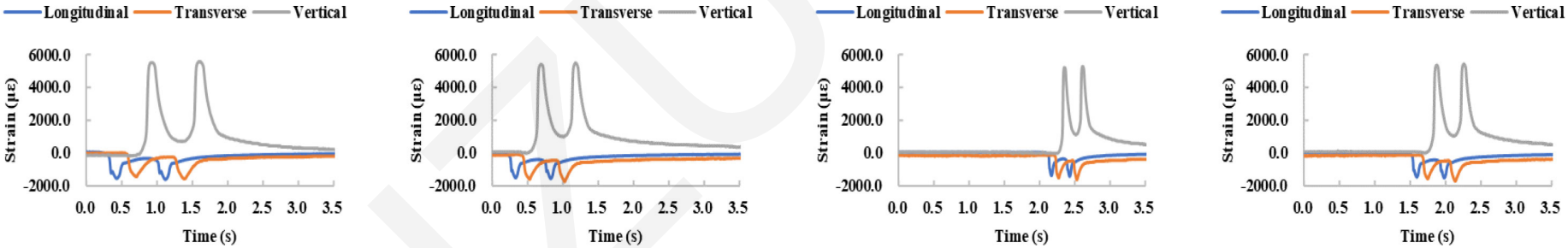


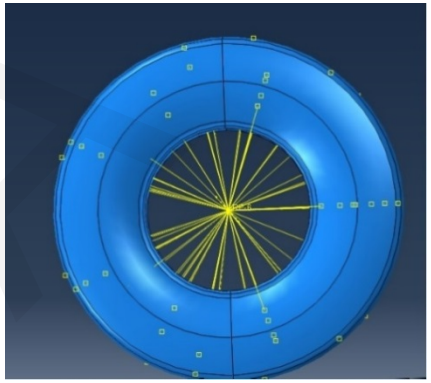
Fig. 3 Three strain curves at different speeds: (a) at 7.2 km/h; (b) at 10.0 km/h; (c) at 12.6 km/h; (d) at 18.7 km/h

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Finite Element Tire-pavement Contact Model

Table 1 Tire Profile Parameters

Tire Profile Parameters	Symbol	Value（mm）
Tire outside diameter	D	1085
Rim diameter	d	508
Tire cross section height	H	288.5
Height of section below the section centerline	H_1	144.69
Height of section above the section centerline	H_2	143.81
Arc height of driving surface	h	13.271
Tire section width	B	293
Width of driving surface of tire	b	228.6
Distance between two tyre rings	C	203.2



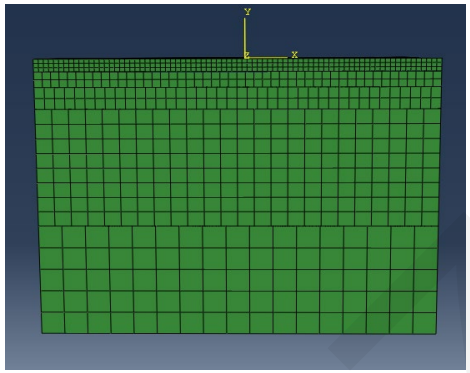
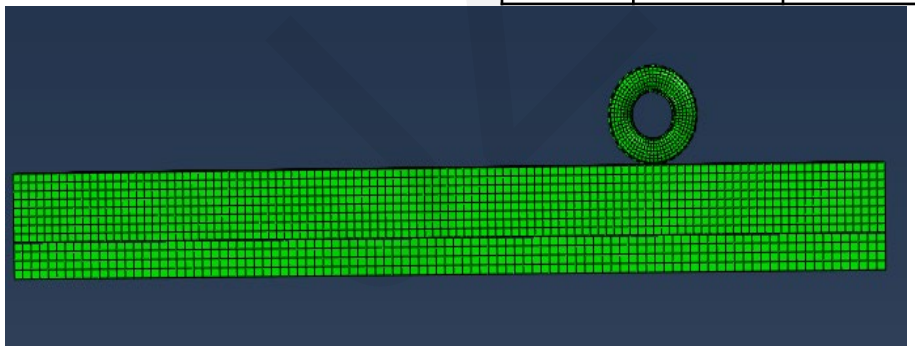


Table 2 Material properties of the full-scale pavement

Layers	Materials	Elastic Modulus (MPa)	Poisson's ratio	Density (kg/m^3)	Damping coefficient（α、β）
Top layer	SMA-16	1550	0.35	2400	0.05
Mid layer	AC-25	1250	0.35	2400	0.05
Lower layer	AC-30	2450	0.35	2400	0.05
Base	Gravel	10000	0.35	2100	0.05
Subbase	Lime soil	2000	0.35	1900	0.05



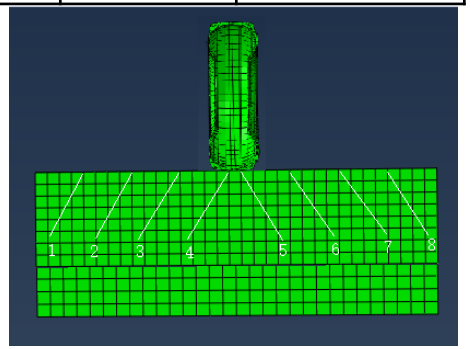


Fig. 4 3D contact model of tire and road surface

The Dynamic Response of an Asphalt Pavement in FEM

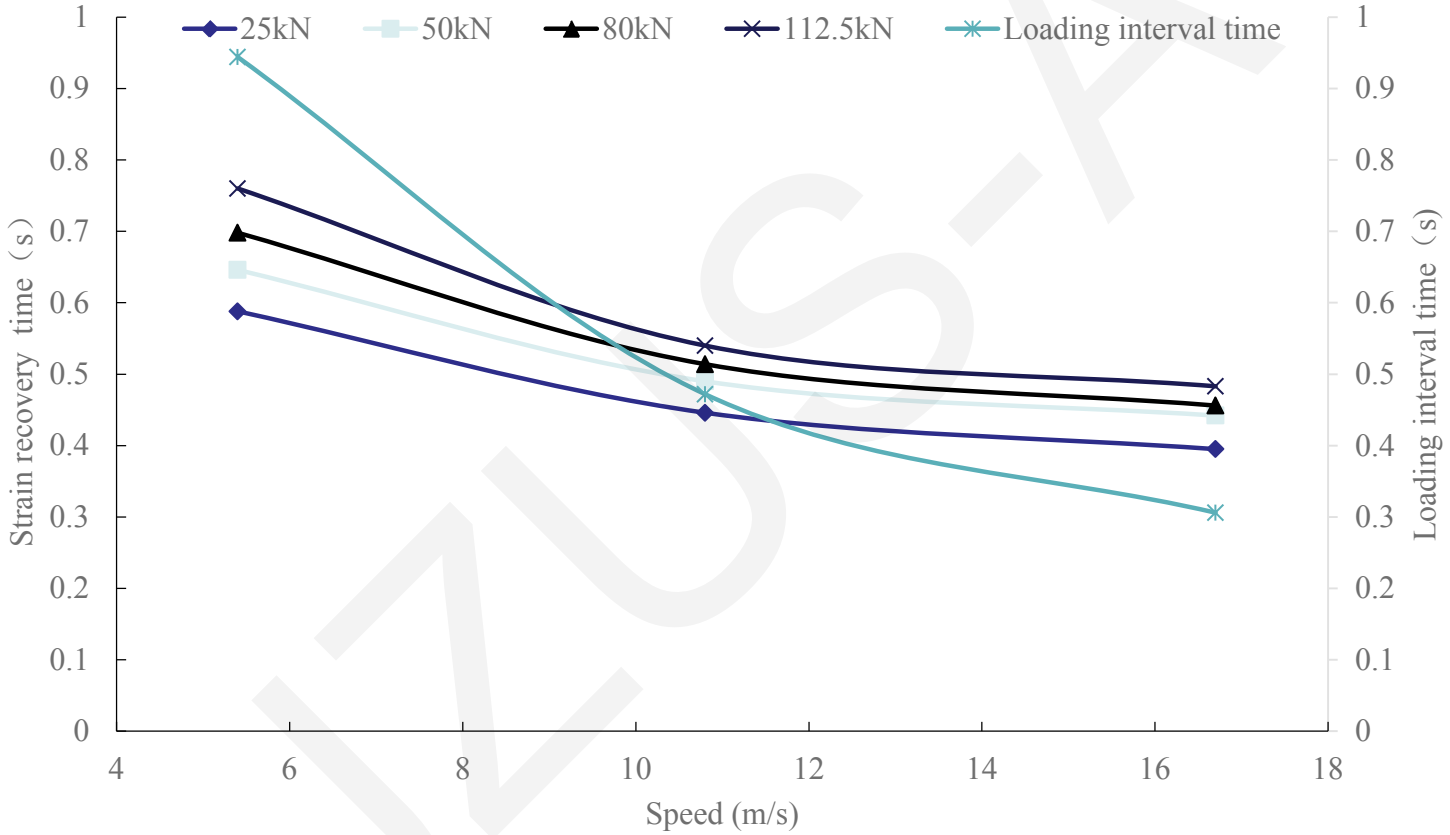
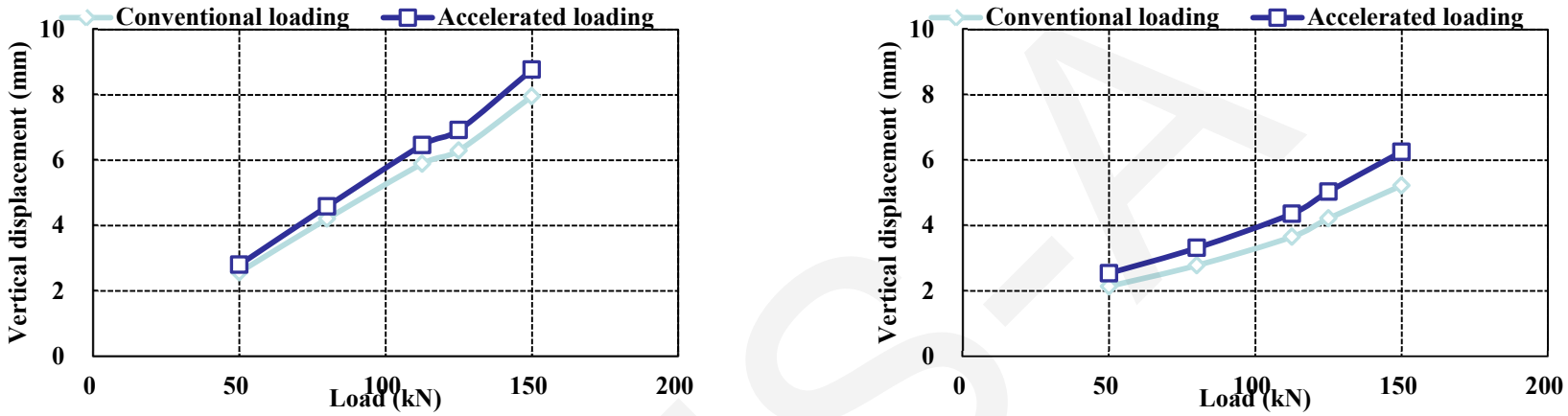


Fig. 5 Comparison of the pavement strain recovery time and the loading interval time at different loading conditions

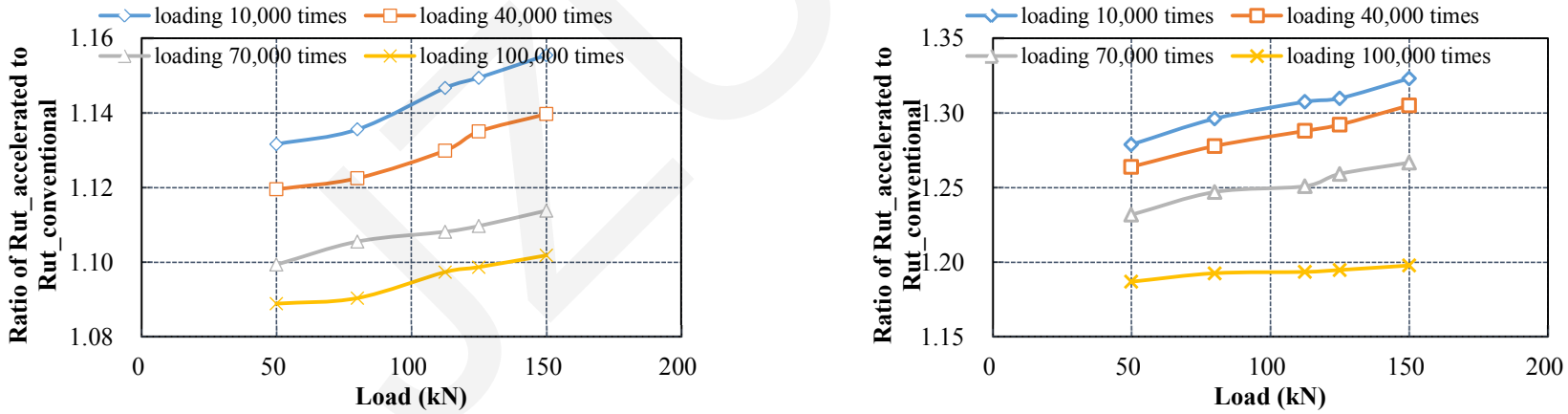
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Rutting comparison between Accelerated Loading and Conventional Loading



(a) (b)

Fig. 6 Rutting curve of accelerated and conventional loading pavements: (a) Speed at 10.8m/s; (b) Speed at 16.7m/s.



(a) (b)

Fig. 7 Ratio of the accelerated rut to the conventional rut: (a) speed at 10.8m/s; (b) speed at 16.7m/s.

Conclusions

- According to the vertical strain recovery time monitored in the process of full-scale pavement accelerated loading, this paper defines accelerated loading as repeated loading whose vertical strain is not fully recovered during the loading cycle.
- Through finite element simulation analysis, it is discovered that the accelerated loading can aggravate pavement rutting under the same number of axle loads.
- When the velocity and the loading cycles are the same, the rutting depth ratio of the accelerated loading to the conventional loading grows with the increase of the load