Impact of Commercial Electric Vehicles on Flexible Pavement Performance

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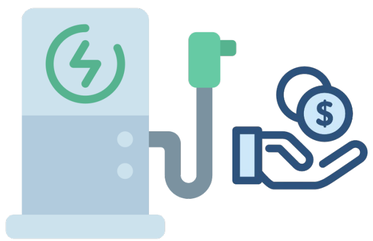
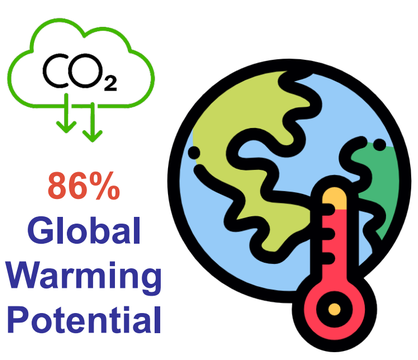
TRUCK ELECTRIFICATION CHALLENGES

Truck electrification will accelerate decarbonization of HD vehicles, reducing global warming potential up to 86% and generating up to 44% energy savings.

Combined impact of **increased torque, axle loading, and weight distribution** needs to assessed for potential modifications in pavement design and maintenance.

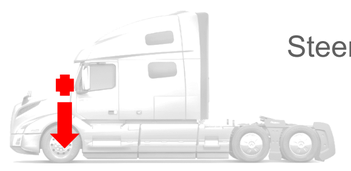
29%-44% Savings



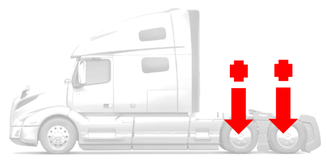


86% Global Warming Potential

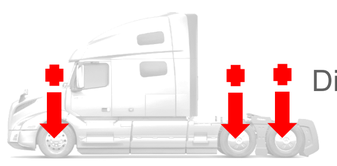
New Weight Distribution



Steering Axle



Drive Axle

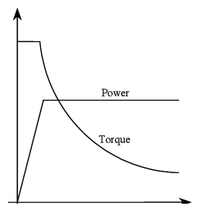


Evenly Distributed

Increased Axle Loading

Electric Battery Pack

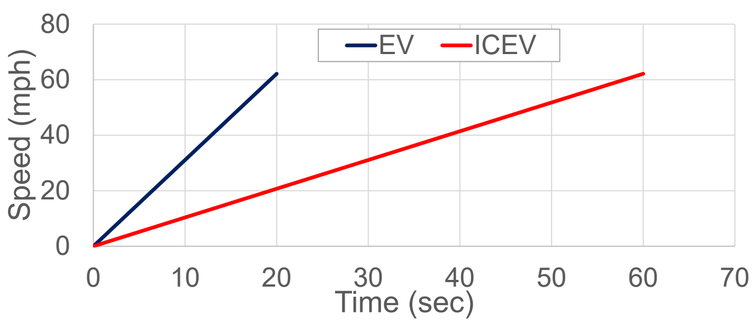
Increased Torque



Torque at 0 RPM

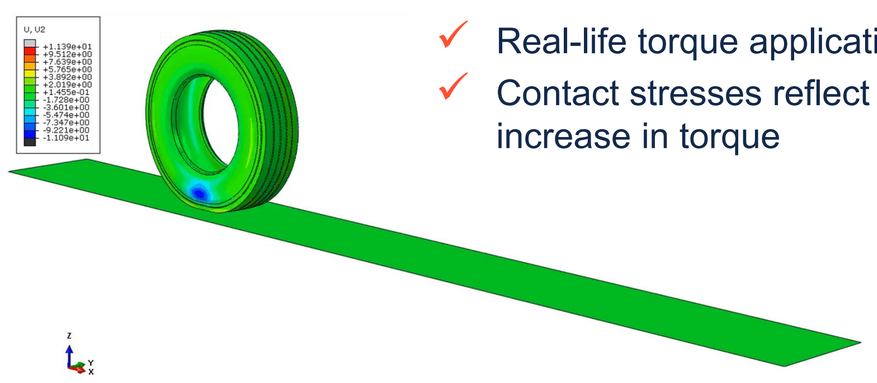
IMPACT OF HEAVY-DUTY TRUCK ELECTRIFICATION ON FLEXIBLE PAVEMENTS

Difference between EV and ICEV



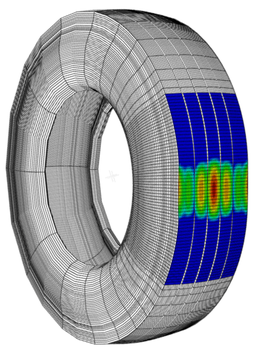
Considerations

- Engine torque ≠ tire toque
- Shorter time from 0 to 100 km/h can be a surrogate of larger torque

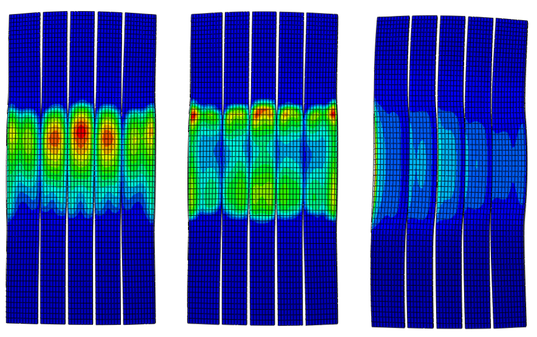


- ✓ Real-life torque application
- ✓ Contact stresses reflect increase in torque

Higher Torque

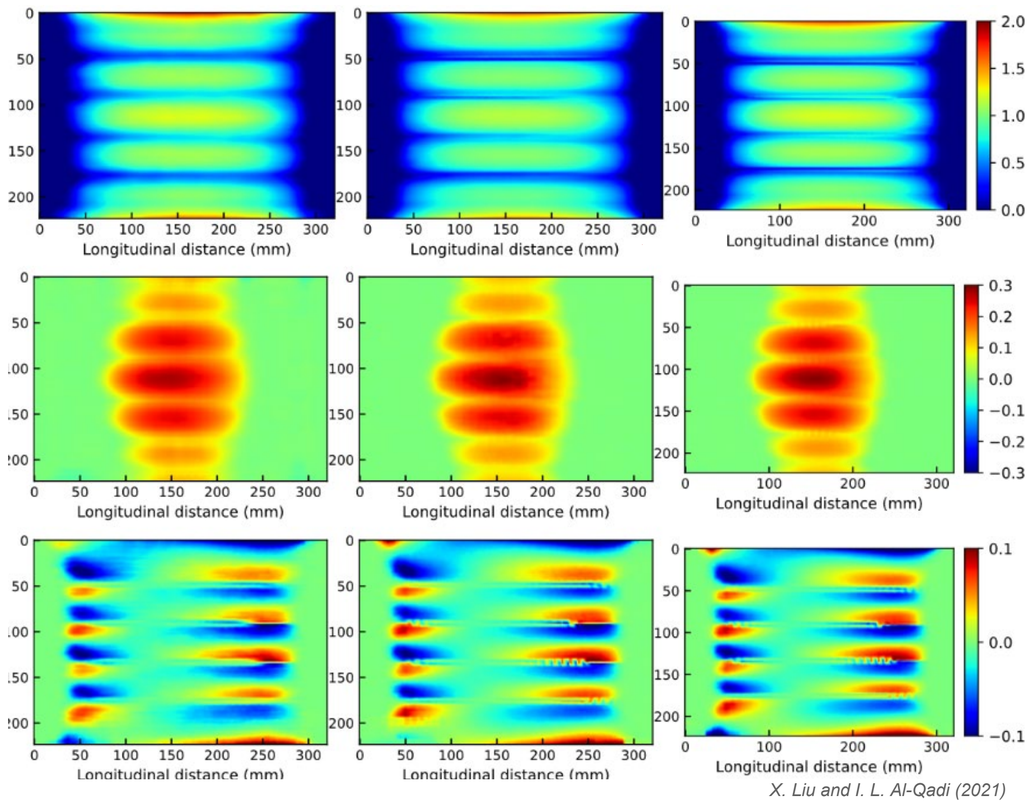


3D Tire Model



Braking Acceleration Cornering

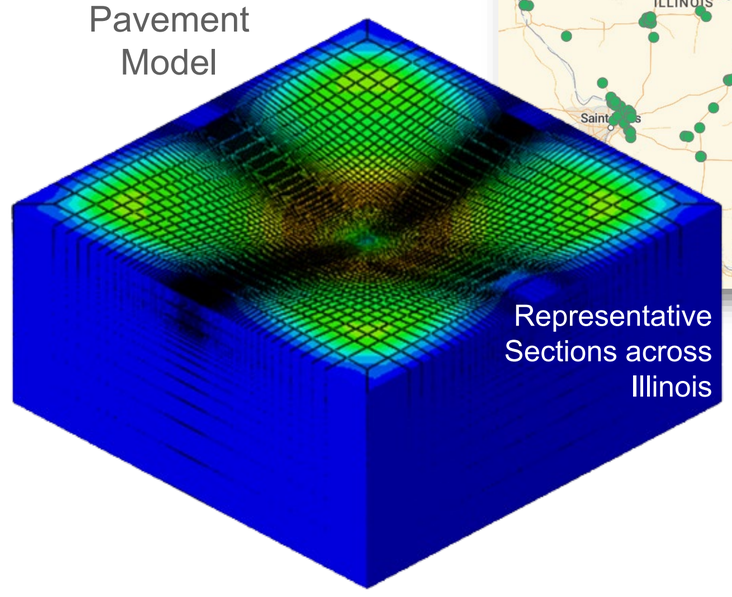
Change in 3D Contact Stress Distribution

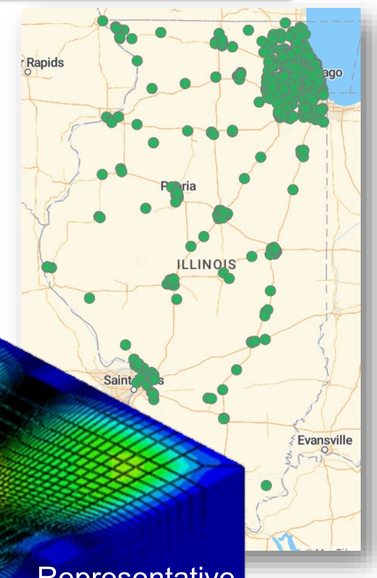


X. Liu and I. L. Al-Qadi (2021)

Impact on Pavement Responses

3D Flexible Pavement Model





Representative Sections across Illinois

FIELD VALIDATION

Accelerated Pavement Testing

- ✓ Instrumented pavement section
- ✓ Heavy-duty truck tire at various rolling conditions

ASPHALT CONCRETE MIXTURE & PAVEMENT DESIGN CHANGES

Traffic Load and Spectra	Material Inputs	HMA Structure Design
Calculate Traffic Factor	Determine subgrade support rating	Determine HMA design strain
★ Adjustment for electric truck torque and load increase	Determine PG binder grade	Determine HMA design pavement modulus
	Determine HMA temperature	Determine HMA design thickness
	★ Optimize and/or recommend suitable materials	★ Optimize and/or recommend thickness changes