ANTILOCK BRAKING OF HEAVY VEHICLES

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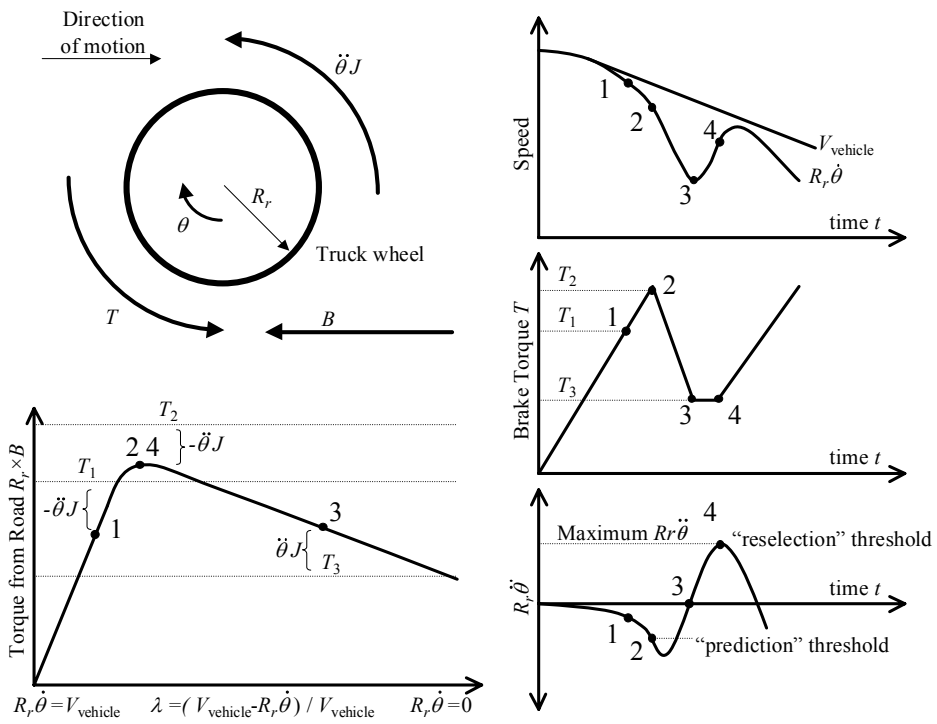
HOW DOES PRESENT ABS TECHNOLOGY WORK?

Current heavy vehicle ABS technology uses simple “bang-bang” control. The figure below illustrates the mechanics of a braked wheel controlled by ABS, highlighting the following states:

1. The brake torque equals T_1 and the tyre forces are stable,
2. The brake torque is increased to T_2 and the tyres saturate resulting in a rapid wheel deceleration and the “prediction” threshold being reached,
3. The ABS reduces the brake torque T_3 resulting in the wheel spinning up again,
4. The “reselection” threshold is achieved, the brake torque is again increased and the cycle is repeated.



Mechanics of a braked wheel controlled by ABS

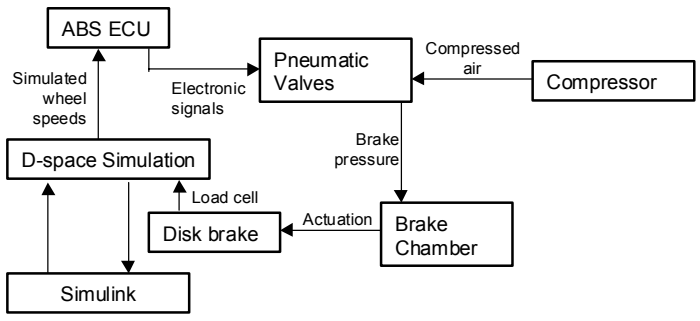
WHAT SCOPE IS THERE TO IMPROVE ABS?

Limited Slip Braking (LSB) controls the slip at an optimum. The implementation of LSB however requires an accurate measurement of vehicle speed. Advances in GPS technology and signal estimation and identification methods make this feasible. Improvements to ABS will be verified using:

- FIELD TESTS,
- COMPUTER SIMULATION, AND
- HARDWARE IN THE LOOP SIMULATION (HIL)

HARDWARE-IN-THE-LOOP (HIL)

Hardware-in-the-loop simulation (HIL) can combine the advantages of both computer simulation and experimental testing. Using this approach a real ABS ECU set-up is tested in a rig, which interacts with a computer simulation of the rest of the vehicle. The exact mechanisms, physics and pneumatics of the braking are tested and suffer no modelling inaccuracies. The vehicle dynamics are simulated, which substantially reduces cost, risk and effort.

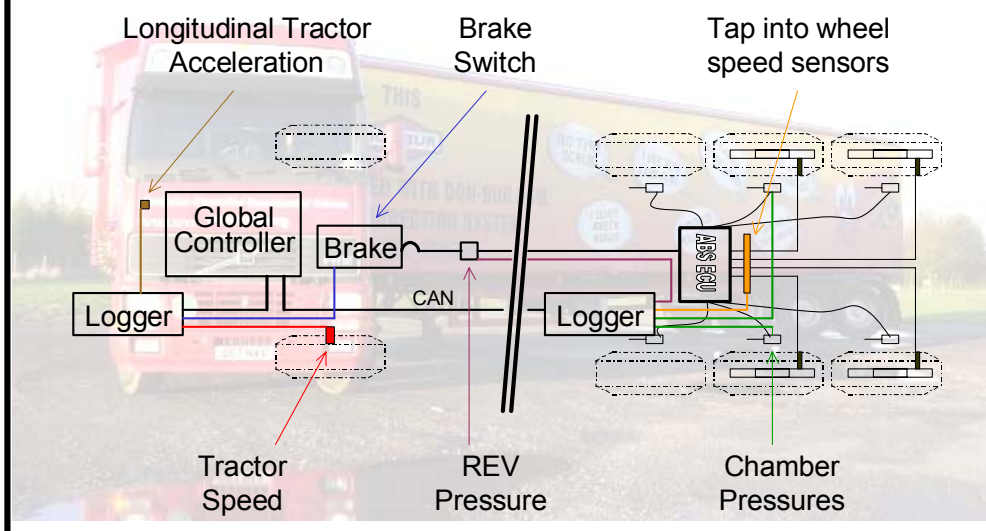


Schematic of proposed HIL rig

INITIAL FIELD TESTS

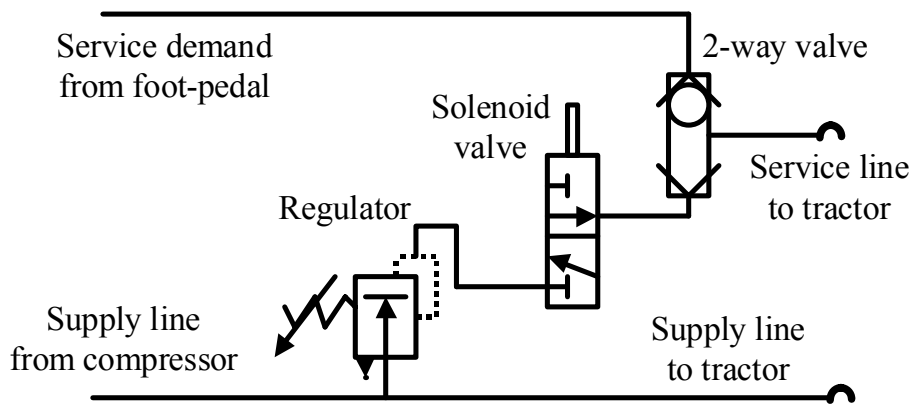
Initial field tests of the ABS braking of a heavy vehicle have been completed. The logged information included:

- longitudinal speed and acceleration of the tractor,
- time when braking is initiated,
- service braking pressure,
- left and right brake chamber pressures, and
- wheel speeds on the second and third axles of the trailer.



Vehicle setup for initial field tests

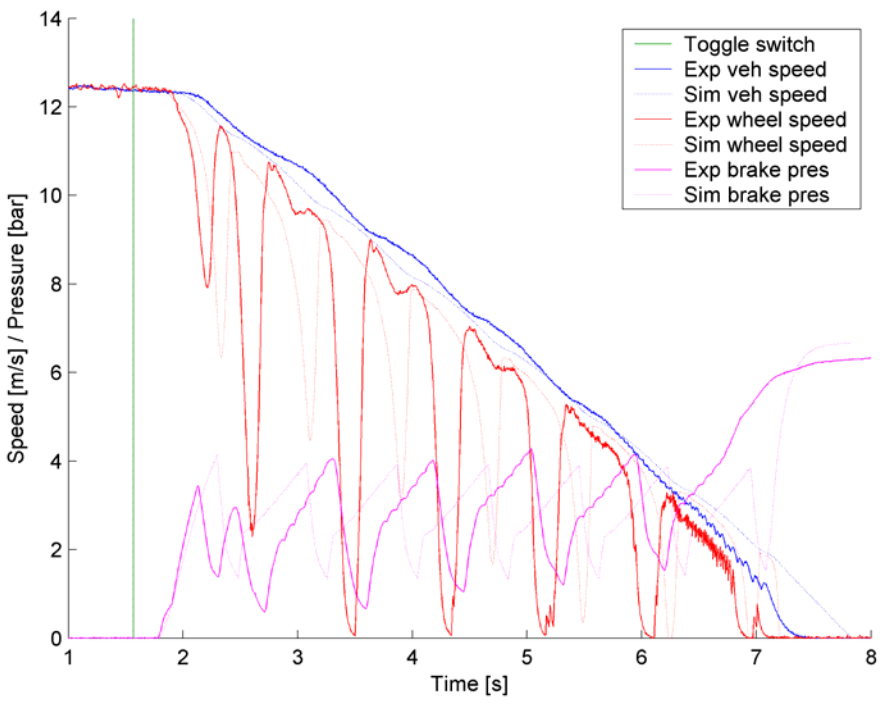
Braking system modifications were inserted on the truck just upstream of the couplings of the tractor to the trailer, allowing the test engineer to apply a constant brake pressure at the flick of a switch.



Modifications to Brake Pneumatics

COMPUTER SIMULATION

Computer simulation provides a means for making quantitative predictions that are representative of the actual vehicle performance without the expense, time, accident risk, effort and repeatability problems associated with real tests.



Comparison of initial field tests and simulation show good agreement

Cambridge Vehicle Dynamics Consortium

University of Cambridge	ArvinMeritor	Denby Transport	Firestone Industrial Products
Fluid Power Design	FM Engineering	Fruehauf Trailers	Haldex Brake Products
Mektronika Systems	MIRA	QinetiQ	Shell UK
Tinsley Bridge	Volvo Trucks		

Braking Control