SEMI-ACTIVE HEAVY VEHICLE SUSPENSION

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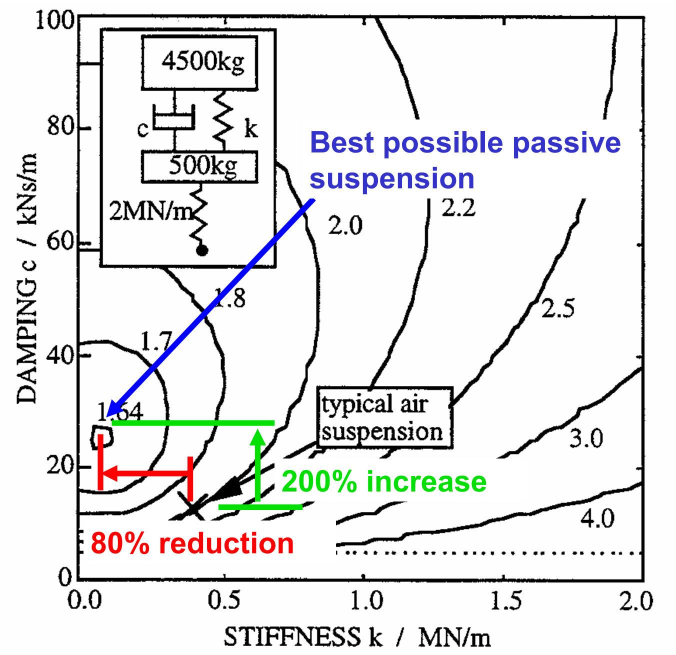
Britain spends £1.2 billion annually on road repairs. A large proportion of it is caused by the passage of vehicles over the road surface - in particular heavy goods vehicles. Use of controlled semi-active suspensions fitted to the heavy vehicle enables the ride related damage they cause to be reduced. Cambridge Vehicle Dynamics Consortium is looking into the use of adjustable suspension dampers to make semi-active suspensions for heavy vehicles commercially viable.



Road damage as a function of suspension damping and stiffness of bounce model, vehicle speed 22m/s [by Dr David Cole]

WHY

- ❑ The ride of most air-suspensioned heavy vehicles could be optimised by additional damping and softer springing. Further improvements are possible using semi-active damping.
- ❑ By controlling the damper force based on measurements of the vehicle's motion and the road profile, it is possible to reduce:-
  - ❑ RMS vertical body acceleration
  - ❑ RMS dynamic tyre force
  - ❑ RMS suspension deflection
  - ❑ Road damage.

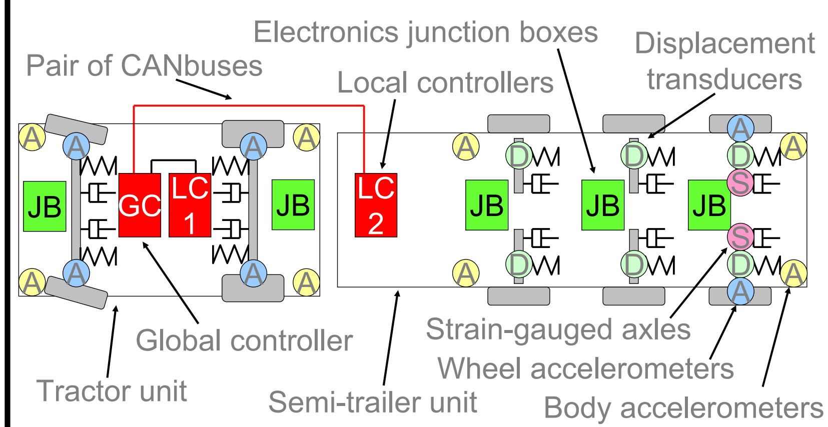
Semi-active heavy vehicle damper (supplied by Koni) used to improve the ride further over the optimum passive case.

HOW

- ❑ As the vehicle travels along the road, a combination of accelerometers and displacement transducers measure the body and wheel vertical velocity ($\dot{Z}_b$ $\dot{Z}_w$).
- ❑ From these measurements, a damper force demand is generated using a "modified skyhook" damping strategy.

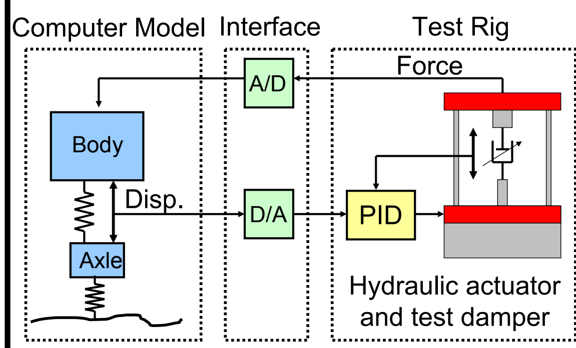
$$F_{dem} = C_m\left[\alpha\left(\dot{Z}_w - \dot{Z}_b\right) + (1-\alpha)\dot{Z}_b\right]$$

- ❑ Damper forces are controlled to track the demand signal.

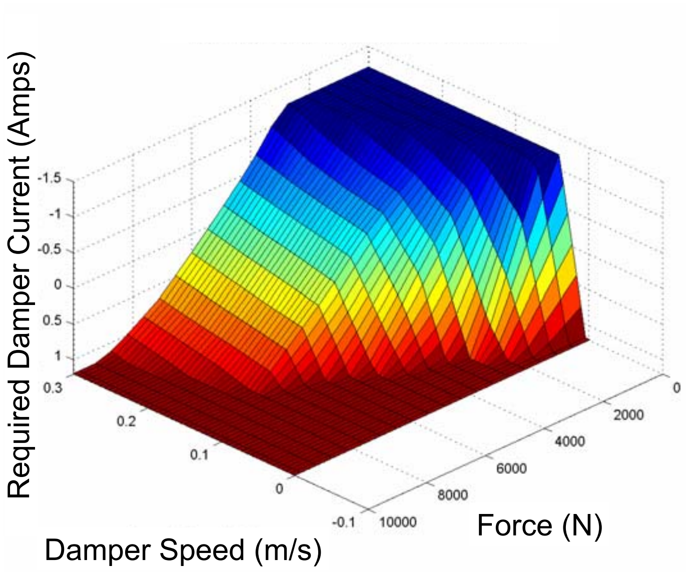


WHAT

- ❑ Laboratory trials were conducted using a Hardware-in-Loop test facility, which simulates the dynamics of the vehicle using the real damper.
- ❑ Field trials of the system have been carried out using a laden tractor - semi-trailer with ten semi-active dampers fitted.



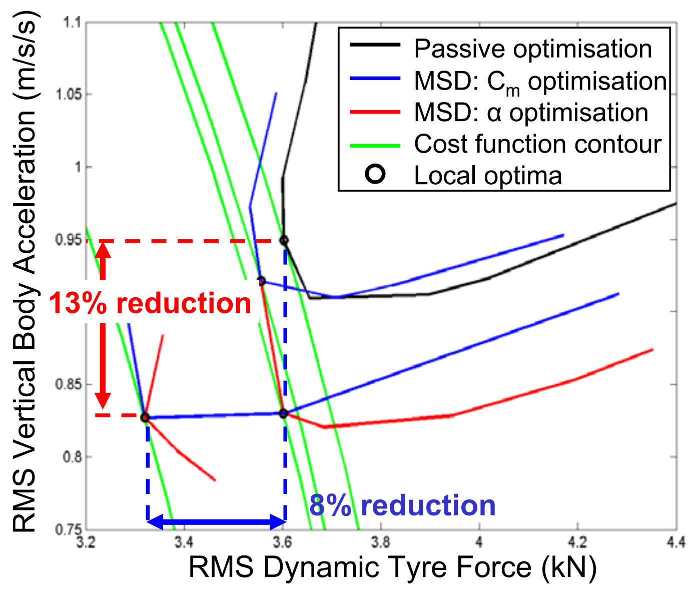
Hardware-in-Loop Test Rig



Measured damper characteristic used to predict control current required to produce desired damper force.

RESULTS

- ❑ The results (see graph) show that both RMS body acceleration and RMS dynamic tyre force can be reduced by optimising the level of passive damping.
- ❑ A further 13% reduction in RMS body acceleration and an 8% reduction in RMS dynamic tyre force results from using the modified skyhook damping strategy.
- ❑ Theoretical work shows that these beneficial reductions can be more than doubled by the addition of preview control in the form of time lag compensation. This will be investigated in future.



Results of HiL tests simulating a quarter car model traversing a principal road at 80km/h. Results show passive and semi-active optimisations.

Cambridge Vehicle Dynamics Consortium

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CONTINUOUSLY VARIABLE DAMPERS