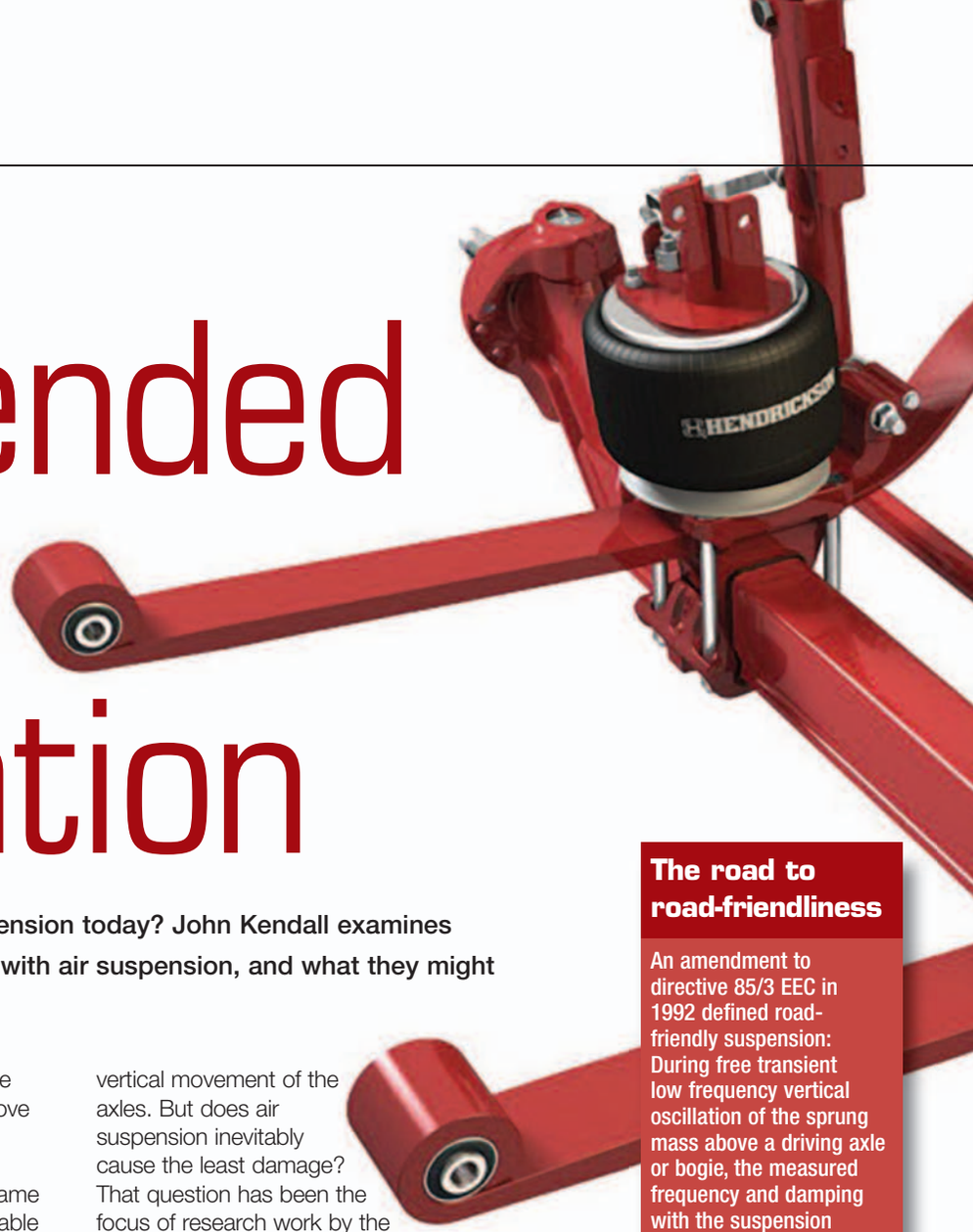
Suspended animation



How road friendly is road-friendly suspension today? John Kendall examines developments and thinking associated with air suspension, and what they might mean for operators and engineers

Since road-friendly suspension became mandatory in the early 1990s, the move away from rubber and steel to air suspension for drive axles has been almost absolute. And it's much the same for tri-axle semi-trailers and trailers, mainly to enable operation at 44-tonnes gcw, where road-friendly suspension is also a requirement.

Since a semi-trailer with road-friendly suspension will therefore be the most versatile, it is likely also to be the easiest to sell on the second-hand market. If the air suspension is also electronically controlled, it opens up other possibilities, too. For example, a diminishing load, resulting in accidental overloading of the drive axle, is familiar territory for many hauliers. So last year Wabco introduced its OptiLoad system, which allows the pressure in the suspension air bellows of the tractor unit and trailer to be adjusted. These alterations can effectively redistribute the axle loadings, without physically moving the load rearwards in the trailer. They thereby help to reduce axle damage due to overloading – and the risk of a fine. Naturally, avoiding overloading also reduces the risk of causing road damage.

The same company's OptiTurn system uses the same control electronics to improve semi-trailer manoeuvrability in tight turns. The technology can either reduce the trailer suspension air pressure or raise the rearmost axle to reduce scrub and again improve manoeuvrability.

Road-friendly suspensions were originally designed to reduce the amount of damage caused to road surfaces as a result of pressure loading from vertical movement of the axles. But does air suspension inevitably cause the least damage? That question has been the focus of research work by the Cambridge Vehicle Dynamics Consortium (CVDC) for a number of years. The consortium is made up of an engineering team based at Cambridge University, working alongside vehicle, suspension, brake and trailer manufacturers, other research organisations and interested parties.

Research back in the 1990s showed that the road friendliness of air suspension depended on a number of key factors that included the matching of truck and semi-trailer suspension systems. So CVDC's most recent work has looked at the effect of fitting semi-active damping systems.

Most vehicles are fitted with passive hydraulic dampers, designed only to deliver the same damping force under all suspension conditions. Since early research by CVDC had shown that road damage could, in some circumstances, be increased by a mismatch of vehicle and semi-trailer suspension characteristics, it seemed reasonable to suppose that, by introducing dampers whose damping force could be varied according to vehicle movement and road characteristics, it may be possible to reduce road surface damage further.

A semi-active damping system is far more affordable than a fully active suspension system, which would manage both springing and damping characteristics. While there might also be safety

The road to road-friendliness

An amendment to directive 85/3 EEC in 1992 defined road-friendly suspension: During free transient low frequency vertical oscillation of the sprung mass above a driving axle or bogie, the measured frequency and damping with the suspension carrying its maximum load must fall within the limits defined in paragraphs 2.2 to 2.5.

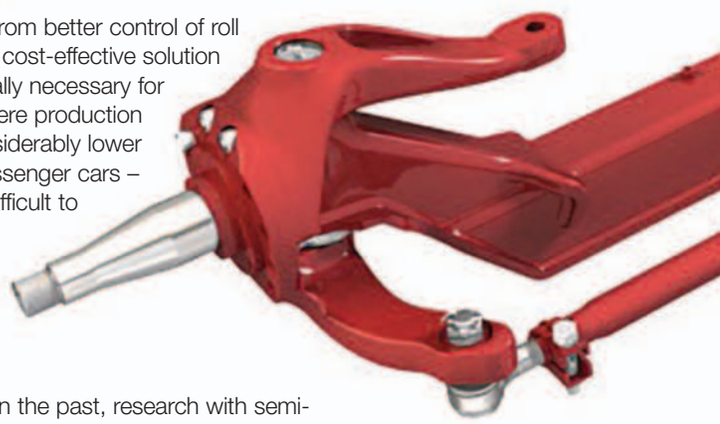
2.2. Each axle must be fitted with hydraulic dampers. On tandem axle bogies, dampers must be positioned to minimise oscillation of the bogies.

2.3. Mean damping ratio D must be more than 20% of critical damping for the suspension in its normal condition, with hydraulic dampers in place and operating.

2.4. The damping ratio D of the suspension with all hydraulic dampers removed or incapacitated must not be more than 50% of D.

2.5. The frequency of the sprung mass above the driving axle or bogie in a free transient vertical oscillation must not be higher than 2.0Hz.

benefits derived from better control of roll characteristics, a cost-effective solution would be especially necessary for heavy trucks, where production volumes are considerably lower than those of passenger cars – making it more difficult to control unit cost.



In the past, research with semi-active damping systems has focused on potential improvements to vehicle dynamics – essentially ride and handling. For this research into the effects on road damage, suspensions specialist Koni provided semi-active damper units, of which ten were fitted to a tractor/semi-trailer combination for field trials.

Tests were also conducted to simulate the vehicle movements when fitted with the standard dampers. On the road-going vehicle, onboard sensors measured such factors as vertical body movement, the force exerted on the tyres and vertical suspension movement – the principle forces that contribute to road damage. This data was then used to counter the movements by adjusting the damping characteristics.

Results from CVDC's trials showed that optimising the level of damping can indeed reduce the body movement and tyre force, which, in turn, reduces the forces transmitted to the road surface that cause damage. This could be further reduced by modifying the skyhook damping strategy. In this way, an additional 13% reduction in body acceleration and 8% cut in tyre forces could be achieved.

Theoretical work also shows that these reductions might be more than doubled by adding further controls to compensate for time lag, and CVDC continues its investigations. Watch this space. TE

Hendrickson's Chinese takeaway

Hendrickson Truck Suspension Systems has developed a suspension for China National Heavy Duty Truck Company (CNHTC), but has said it is also applicable to Europe and north America, and is in discussions with all the major truck and trailer manufacturers.

HUV is a heavy-duty rubber suspension that Hendrickson says should provide improved durability and weight savings to enable increased truck payloads, compared with traditional designs.

It was engineered with lightweight, durable components and is 430kg lighter than competitive six-rod suspensions, traditionally used in China. However, although light, the system has already demonstrated its durability through extensive component and field testing, according to the suspension manufacturer.

The 27-tonne capacity HUV system was launched primarily in tractor applications and straight trucks with defined hauling capacities. Hendrickson says that future versions will be developed for higher capacity straight trucks and heavy-duty dumper applications.

In operation, rubber shear springs carry the majority of the vertical load in the empty condition, resulting in a soft ride. As the load increases, the progressive rate springs deflect proportionally, increasing the stiffness of the suspension, without degradation in ride characteristics.

HUV's balance of empty ride quality and loaded stability not only provides driver comfort, but also cushions the load and protects the chassis and body equipment from excessive vibration and road shock.