Braking with

Brakes and braking systems are seeing a greater rate of change than at virtually any time in the history of their development. Brian Tinham looks behind the scenes

Carl Dibble and Gary Brown of Knorr-Bremse: In some cases, it's not possible to avoid a collision, but new systems will take a lot of the kinetic energy out of the travelling vehicle pre-impact

The big news for truck and trailer braking systems has less to do with the brakes themselves and more to do with the stability control and emergency braking systems, due to become mandatory for type approval from the end of this year. Or so you might think. In fact, another big story is the emergence of fully electromechanical brakes that promise a full 15% improvement in stopping distances, even compared with the best current electro-pneumatic technology. And there's the small matter of the friction materials themselves: making the right choice may not be as simple as it seems.

But let's step back for a minute: in March 2010, we reported on the European Commission's Regulation 661/2009/EC, also known as the General Safety Regulation, which was intended to simplify safety requirements for passenger and freight vehicles, replacing around 50 directives. Nearly 18 months on, and the deadlines for installing ESC (electronic stability control), AEBS (autonomous emergency braking system) and LDWS (lane departure warning system) on virtually all commercial vehicles are looming large.

From November this year, ESC will be required for first type approvals on all vehicles having two or three axles and weighing more than 3.5 tonnes gvw. Then, from November 2013, fitment will be mandatory on all such newly registered vehicles. The only exceptions are buses, and note also vehicles with more than three axles, such as big wreckers and moving cranes. The thinking is apparently that such vehicles are relatively slow moving, so less likely to warrant the on-cost – although sharp-eyed transport engineers will be quick to point out that tippers aren't renowned for hanging around.

In a similar vein, AEBS and LDWS will be required for type approvals on trucks and buses from November 2013, and mandatory for new registrations in the EU two years later.

Acronym soup

ESC is, of course, not new. Wabco, for example, launched its first system in 2001, as an extension of its EBS (electronic braking system), introduced in 1996 – which itself superseded 1980's mechanical ABS (anti-lock braking systems). EBS cut the time for braking signals to be transmitted from the pedal to the foundation brake actuator, from 400msec to near real time, by moving from pneumatics to electronics – the first iteration of brake-by-wire (although pneumatic backup lines remain).

tradition

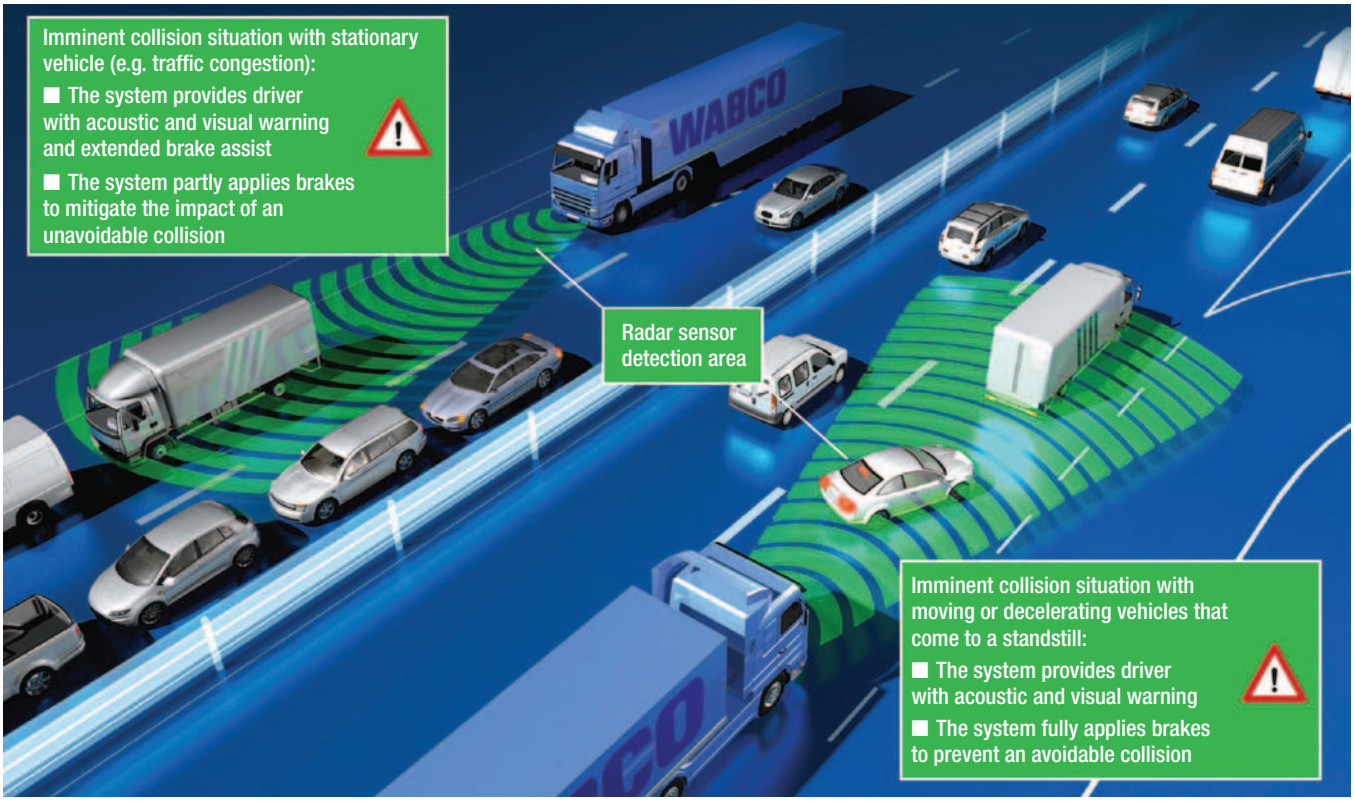
Moving up to ESC meant adding sensors to measure steering angle, lateral acceleration and yaw, to establish whole vehicle (not just individual wheel) movement, driver intention and proximity to critical stability limits – so that corrective action could be imposed. And, given that correcting vehicle stability (whether on rigids or combinations) may necessitate more than wheel braking, modern systems also communicate with, and can control, engine torque.

AEBS is yet another extension, adding data from any or all of forward-looking radar and Lidar (light detection and ranging) inputs, from modern adaptive cruise control (ACC) systems, as well as video (as used in LDWS). Such systems autonomously apply full emergency brakes and engine torque reduction when the system detects an imminent collision and the driver fails to react to warnings.

Wabco calls its systems OnGuardMax (first seen at the Hannover IAA show in 2008) and OnGuardPlus (launched at last year's IAA), the latter claiming to be the first system to comply with the EU's AEBS requirements for 2013. Each system combines elements from the firm's ACC, CWS (collision warning system) and CMS (collision mitigation system). However, whereas OnGuardPlus uses a radar sensor to react to collision situations, OnGuardMax uses video and laser distance sensors to further improve object dimensioning and better anticipate danger. Wabco says it is already developing OnGuardPlus for Hyundai Motor's new range of heavy duty trucks and expects to start deliveries for series production in 2013. Meanwhile, OnGuardMax is due for general availability for bus and truck OEMs in 2015.

Why so many sensor types? Wabco's chief technology officer Dr Christian Wiehen explains that it's about accurately, quickly and reliably differentiating between objects that matter – for example, slow-moving or stationary traffic ahead – and those that don't, such as street furniture or bridges. Failure to do so might otherwise trigger a false (and very dangerous) alarm, he points out.

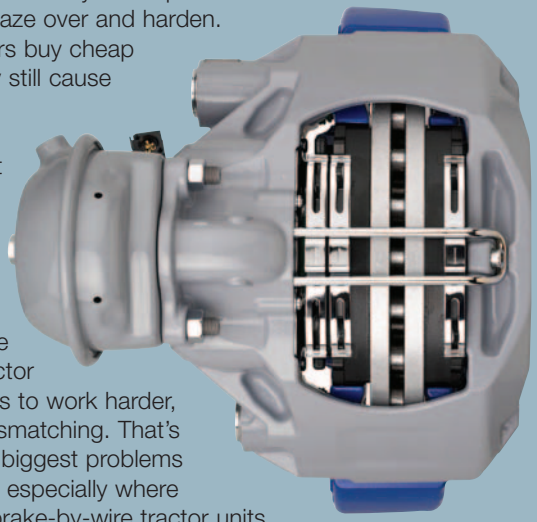
"With OnGuardPlus, the radar sensor monitors the area in front of the vehicle and makes sure action is taken, if the [safe braking] distance is not maintained and the driver fails to respond to a



Friction material demystified

Friction material is friction material is friction material, right? Not quite. John Hibbert, technical sales engineer at Federal-Mogul, points out that, just as with the callipers themselves, materials and friction modifiers are under constant development, enabling technologies such as ABS and latterly ESP and AEBS systems to perform as intended.

He cites key advances as improving temperature stability and friction consistency to ensure brake harmonisation between tractor units and trailers. "For example, we've long since designed out problems with early brake pad materials that used to glaze over and harden. But, if operators buy cheap pads, this may still cause problems and they may have trouble when it comes to passing MOT tests," warns Hibbert.



"They are also likely to be forcing the tractor or trailer brakes to work harder, because of mismatching. That's still one of the biggest problems in the industry, especially where they're using brake-by-wire tractor units, but conventional trailers, or trailers without ABS."

But poor practice aside, Hibbert's point is that there's little gain in investing in EBS from a top-of-the-range equipment supplier for a 44-tonne tractor and trailer combination, and then falling at the final hurdle of the friction material itself. "It's not even necessarily about the material formulation; it's the manufacturing processes, such as triple baking and pressing to 100 tonnes, that dictate the braking parameters. And there's always the possibility of undue disc wear, due to cheap heavy-duty materials, or material falling off, if the backplate attachment isn't to specification."

Hibbert points to Knorr-Bremse's SB7 air brake calliper: "A cheap friction material manufacturer would offer one type for that pad shape. We do nine, using several materials for different braking factors. For example, we have one for a Scania city bus, which matches its duty cycle, and another for Iveco, another for trailers, bearing in mind that trailer brakes are governed down and need a good, high friction coating, so that they work well unbedded – and so on.

"My recommendation is to look less at the price of the pad and think more about compatibility, pad life and braking efficiency. Fleet engineers are also welcome to consult us. If, for example, they're running a tipper fleet in the north of Scotland and seeing serious wear issues, we might suggest heavy-duty alternatives. They might be more expensive – and if you were trunking up and down the motorway you wouldn't need them – but they would be better suited to this duty and last a lot longer."

sequence of warning events," explains Wiehen. "First, a buzzer sounds, then there is a short brake application, to jerk the truck, and then the system applies full emergency brakes to at least mitigate a collision that has become inevitable."

It's a similar story at Knorr-Bremse, although in its case fusing forward-looking radar and camera sensor data – the former to range obstacles, and the latter to add size and depth information and immediately detect potentially dangerous situations.

As Gary Brown, who looks after OE sales for Knorr-Bremse in the UK, puts it: "It's all about reducing the scale of an incident. In some cases, it's not possible to avoid a collision, but the system takes a lot of the kinetic energy out of the travelling vehicle before the impact… The only issue for us, as manufacturers, is that, while aEBS will be mandated, the precise function and degree of mitigation have not yet been defined in the standards."

Which is why Knorr-Bremse's current production AEBS systems, mostly being fitted in the US (where the appetite for such systems is currently greater), will need to be tweaked ahead of the European regulations going live. Brown: "By 2015, the systems meeting full EU legislation will be based on a new generation of AEBS. The camera and radar technologies will be even more advanced and the manufacturing methods will also be different, because, clearly, the volumes will be much higher."

But should technicians be concerned about maintenance of these upcoming systems? Knorr-Bremse and Wabco agree that maintenance is not a problem. Carl Dibble, Knorr-Bremse's service network co-ordinator, describes it as black box stuff, along much the same lines as the existing EBS and ESP, currently fitted on premium DAF, MAN, Mercedes-Benz and similar trucks. "There are no adjustments and these systems have very capable self-diagnosis features. For technicians, the issue is having an ability to diagnose faults, using the OEMs' diagnostics or the braking system suppliers' software," he says. "To minimise repair costs and vehicle downtime, it's about being competent with diagnostics."

So much for advanced braking control, but what about the brakes themselves? Stories of brake-by-wire systems, for example, which dump traditional pneumatics in favour of electromechanical actuation, have been around for years, but equipment has never emerged beyond the test track. Now, however, while Knorr-Bremse and Wabco remain tight lipped – beyond conceding obvious technical and packaging advantages, if the technology can be made reliable – Haldex is shouting from the rooftops.

Fredrik Seglö, product manager at Haldex, says that electrical braking systems will increase traffic safety and improve truck handling. Speaking in Borås, near Gothenburg, Sweden, at the final EU-funded HAVEit (Highly Automated Vehicles for Intelligent Transport) R&D project demonstrator, he claimed that his company's new brake-by-wire-system, developed to meet the ECE-R13 brake regulations, shortens braking distances by 15%.

Electric performance

Delegates were introduced to the new HAVEit demonstrator truck – the result of a project involving Volvo, Haldex, the University of Stuttgart and electronics specialist Explinovo. Setting aside a striking resemblance to the truck used at CVDC's (Cambridge Vehicle Dynamics Consortium) technology demonstrator late last year, which also harnessed Haldex's experimental electric motor-driven electromechanical brake system, it was impressive.

Seglö describes the system as enabling "increased braking performance for actuation and advanced slip control, resulting in an improved stability control and reduced stopping distance". He also says that the system "uses the principle of self-enforcement for generating brake force", in order to "reduce energy consumption, compared to alternative systems". Essentially, although a brushless dc electric motor applies the disc pads, the system behaves rather like a drum brake, using the vehicle's own momentum to pull the pad onto the disc, so massively reducing the required motor power output. The motor merely moves the pad up a ramp until it engages and then controls the force, with minimal current draw.

"Apart from these advantages, the driver has a better pedal feeling [and] the truck benefits from improved brake balance and vehicle stability," states Seglö. "The HAVEit demonstrator is an important milestone, as it is designed in accordance with the ECE-R13 regulations [so is] a major step towards commercialisation of this technology", he adds.

Incidentally, he also explains that the system uses dual systems to ensure safety. In fact, it uses dual redundant electrical systems developed by the Faculty of Aerospace Engineering at the University of Stuttgart, as well as FlexRay/CAN communications, developed by Explinovo, between the brake and vehicle systems. TE

Dr Christian Wiehen, Wabco's chief technology officer

VOSA braking update

Industry proposals to move to testing commercial vehicle brakes (freight and PSVs) against maximum authorised mass (MAM), rather than design weight, remain in abeyance. VOSA vehicle standards manager Andrew Cattell says that, although the agency is keen to work with the industry and recognises that MAM would level the playing field for vehicles, there will be no change when the new Testing Directive comes into force in January next year.

Cattell cites two key reasons. First, moving to a MAM regime will require VOSA and the existing DPs (designated premises) and ATFs (authorised testing facilities) to invest in potentially expensive updated software and technology, with no clear benefit to the public – only to the HGV industry. Secondly, any such change could force a marked change in MOT first pass rates, as the industry becomes acquainted with the new requirements – the big worry being the PSV sector, where operators are accustomed to calculation-based unladen testing.

"At the moment, the commercial climate isn't right for this scale of change," states Cattell. "Additionally, while we accept there are discrepancies with the existing system in testing near identical vehicles on stopping power, because of theoretical differences in their design weight, we also need to be sure of getting meaningful results that don't prejudice road safety and the industry."

Cattell sees the sense in the bus and coach industry coming into line with the HGV world, and moving to testing vehicles to applicable axle and gross vehicle weights, instead of using outdated calculations – particularly given the unladen weight of modern buses. However, he maintains that the agency needs to effect the change in a controlled manner.

"Bus and coach operators won't have to do anything differently in the test itself: if more than half the wheels lock, then they meet the efficiency performance, provided the others are within limits. They just need to conduct their pre-tests bearing in mind the vehicle MAM, rather than the old unladen weight calculation before they present the vehicle to us for inspection… We have asked industry to come back to us with evidence-based data and I understand they are working on a proposal."