ARTSA's Brake Test Investigation – Part 2

In the first of these three articles, I described the results of ARTSA's investigation into load-sensing brake valve set-ups on a semi-trailer. This article considers the braking performance of antilock brakes and the influence of tyre-inflation pressure on stopping distance on a semi-trailer test vehicle.

The tests were conducted by the Australian Road Research Board (ARRB) at DECA's Shepparton test track in July this year. ARTSA gratefully acknowledges the excellent commitment of ARRB and the financial sponsorship of the Queensland Department of Transport and Main Roads. ARTSA is also grateful to Volvo Australia for loan of the truck and BPW Transpec for loan of the semi-trailer.

The prime-mover is a Volvo FH series 6 x 4 truck. The steer axle has a taper leaf spring suspension and the drive group an airbag suspension. All axles have full-air disc brakes. The trailer was manufactured by MaxiTrans and has a tri-axle rear group with BPW axles and brakes. The trailer has an air-bag suspension and full-air disc brakes. The steer-axle tyres were 295/80R22.5 and all other tyres were 11R22.5.

Both vehicles have Electronic Stability Control (ESC), which includes an antilock brake function (ABS). Because the tests were on a straight and dry roadway, the stability control features never came into operation and it was the ABS that operated when the wheels locked up. The ABS function could be turned on or off on both truck and trailer, so the comparative stopping distance was determined with and without ABS on each part. One purpose of these tests was to determine whether antilock brake operation increased the stopping distance.

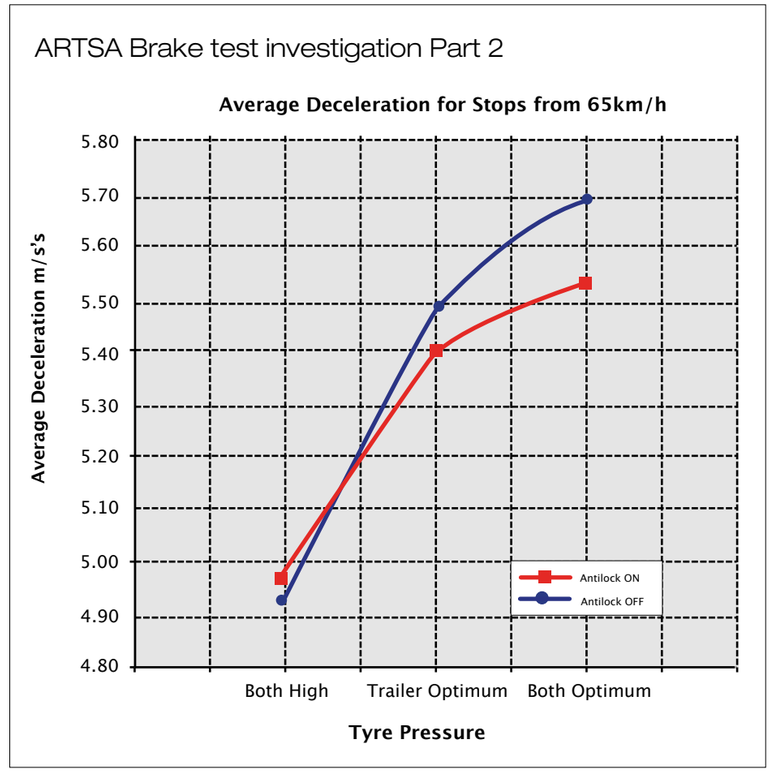
The vehicle was braked hard to stop on a dry straight road from an initial speed of ~ 65 km/h. It was lightly laden (except that a load frame was left installed inside the tautliner trailer). The axle-group weights were: steer axle - 6150 kg, drive group - 8850 kg, tri-axle trailer group - 8650 kg, all up weight - 26,650 kg. Wheel lock-up was observed to occur on the drive- and trailer-axle groups (but not the steer axle) during tests.

There is an optimal tyre footprint for braking. To maintain the optimal tyre footprint the tyre inflation pressure should change with load on the tyre. If properly set, a Central Tyre Inflation (CTI) system can manage tyre pressure according to manufacturer's recommendations. Some stopping tests were conducted with the tyre pressures set to high (656 kPa = 95 psi which is appropriate for a fully loaded tyre) and low (290 kPa = 42 psi which is optimum for the lightly-laden tyre) to determine the effect of tyre pressure on stopping distance.

Results

The tests for each condition were repeated five times and the results for each point shown in the graph are the averages of five tests. The results show:

- With all the tyres at full pressure (656 kPa), the stopping deceleration is about equal whether the ABS is ON or OFF.
- When the tyre pressure is reduced, first on the trailer and then on both the trailer and the truck drive wheels, the average deceleration increases. For the unladen vehicle, it is advantageous to have optimum tyre pressure on the drive- and trailer-axle groups.
- The vehicle with optimum tyre pressure achieves about a 15 % higher average deceleration than the vehicle with high tyre pressure. This occurs because the tyre footprint at low pressure can use the available road friction most effectively.
- The vehicle with the antilock brakes OFF achieves a higher average deceleration than with the antilock brakes ON. The difference is greatest at low tyre pressure. This occurs because the vehicle with low tyre pressure experiences less wheel lock-up that the vehicle with full tyre pressure. Antilock brake operation temporarily releases the brakes on the locked-up group of wheels and then reapplies them. Consequently, during each ABS modulation cycle some stopping distance is 'lost'.
- For reference, the in-service rules (AVSRs) require that a combination vehicle can achieve an average deceleration of 2.8 m/s2 from 35 km/h. This was easily met in all tests.



The tests show that for this test vehicle, setting the tyre pressure low to give about peak road friction, reduced stopping distance by between 10 – 15 per cemt compared to the full-load tyre pressure, because wheel lock-up is not as prevalent. Tyre pressure management (using a CTI) should give improved stopping distance (and wear) performance.

Having antilock brakes active increased stopping distance by ~ 3 per cent (when the tyre pressure is set for peak road friction). A greater difference can be anticipated on a gravel road because modulation will be more frequent. The driver was experienced at brake testing and he probably achieved shorter stops when the ABS was off than a typical driver could.

ABS is known to improve directional stability whilst braking in a turn. This aspect will be discussed in the next article.

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