Welcome and unwelcome brake applications

This article is about the effectiveness of parking brakes and emergency brakes on heavy vehicles. It is also about road crashes. I recently investigated a rollaway incident involving a prime mover and semi-trailer combination. Anecdotally, on average one heavy vehicle rolls away every day in Australia. Of these incidents, one per week requires emergency services intervention. How does this happen? The driver forgets to – or doesn't want to – apply the parking brakes.

I have also investigated a serious rollover that occurred as a consequence of the supply line to the trailer coming out on a bend. The trailer went sideways. In that case, dirt got into the bayonet air fitting and clogged up the locking ring, causing it to not lock reliably, so it popped out whilst travelling. In another case, a mechanical failure in the self-sealing bayonet fitting blocked up the supply port, leading to a dangerous skid.

Spring brakes on heavy vehicles are forceful and can lock up wheels. How forceful? The brake design rules require that a fully laden vehicle will hold on an 18 per cent grade. That is, a grade with an up/over ratio of 0.18. This works out to be an angle of 10.2°. The minimum force that the parking brake must provide, then, is: gross vehicle mass (GVM) (or gross trailer mass, GTM) x Sin 10.2° = 17.7 per cent x GVM (or GTM). If the parking brakes were to be applied whilst moving, this force would produce a deceleration of about 0.18g. Compare this to the design rule service-brake standard of about 0.45g from 60km/h. The parking brakes should be able to stop the vehicle at about one-third of the force of a full service-brake application. But the retardation force is unbalanced and not supplied on all axles. Park brakes on US–designed trucks are activated by spring-brake chambers on the (two) rear axles, and never on the front. This design facilitates 'emergency' brake performance when there is a substantial loss of air pressure in the rear brake circuit. In that case, an 'inversion valve', which does nothing when the rear brake air pressure is above ~400kPa, comes into play. It activates the rear spring brakes in a graduated way to provide some graduated rear-axle braking of the foot pedal. The parking brakes are always on the rear axle group, because that is where emergency parking brake performance is needed when a fault occurs. The rear brakes typically provide two-thirds of the service-brake performance on a US truck.

European and Japanese trucks have a different 'emergency' brake design. The emergency brake is activated in a graduated way, using the parking brake lever. Before reaching the parking position, the parking brake lever causes the service brakes to be applied using auxiliary air pressure. Once the parking position is reached, the truck spring brakes come on. Note that in Europe, the trailer is usually parked on the service brakes and not on the spring brakes.

Some European trucks sold in Australia are modified so that parking the truck will cut the trailer air supply and therefore bring on the trailer spring brakes, but it has not been mandatory to do so in Australia. There is a serious problem with this situation. If the trailer is parked on its service brakes and it is being uncoupled, pulling out the service coupling before the supply coupling is pulled out will release the parking brakes on the trailer. It might move unexpectedly. Always pull out the supply line first as this ensures that the trailer spring brakes are on.

Actually, the term 'emergency brake' only applies to trailers. ADR 38 requires that the spring brakes come on as emergency brakes, should the trailer break away. The minimum emergency brake deceleration performance is 0.18g. The truck rule 35 is silent about how the trailer is to be managed during a truck emergency-braking event. The US scheme has the trailer service brakes controlled off the foot pedal, whereas the European system has the trailer service brakes controlled off the parking brake lever. The Japanese air brake truck system uses the parking lever to bleed air out of the truck spring-brake actuators, according to lever position. The trailer spring brakes are not activated until the lever gets to the bottom, where the trailer air supply is cut off.

A new Australian brake rule, ADR 35/06, is under development. This will mandate vehicle stability control (VSC) on prime movers, but not on rigid trucks. Some manufacturers cannot supply VSC on some rigid truck models, and so the Australian authority will not force VSC on rigids, even though many other makes do have it. When this rule is finally mandated, it will also require the trailer supply line to be cut when the truck is parked.

Trucks with air/hydraulic brakes usually have a parking drum brake on the tailshaft. This is notorious for being out of adjustment, which makes the parking braking performance unreliable. Adjustment must be done routinely.

Design rule development is painfully slow in Australia. The Federal Government requires that new regulations be justified with a 'Regulation Impact Statement' that is acceptable to the Office of Best Practice Regulation (OBPR). It also requires that additional costs resulting from the regulation are offset with savings found by rescinding other regulations. Whilst this approach is laudable, it has one serious downside. Regulation changes, such as the introduction of VSC, take too long to introduce. These delays do not happen in Europe or the US. Consequently, whilst Australia is the world leader in road-access reform, it is a laggard when it comes to mandating safety equipment on trucks via the design rules.

Back to emergency brakes. The sudden and full application of the spring brakes whilst the vehicle is moving is likely to lock up wheels. As a guide, a spring-brake actuator will produce about half the push force of the service-brake actuator at full service-brake level. That is, the parking brake, when it is applied fully, will produce about half the retardation force of the service brake on the axle to which it is fitted. For a US truck, the rear wheels are likely to lock up if the parking brake is suddenly applied. Additionally, for a semi-trailer combination, all of the trailer wheels are likely to lock up. Sudden application of the parking brakes on a prime mover is likely to see one or both vehicle parts go sideways. The situation is slightly better for a European or Japanese truck, because the wheel lock-up is likely to occur on one front axle and one rear axle, so the truck has a better chance of going straight. Irrespective of how parking brakes work, an anti-lock braking system (ABS) will not protect against wheel lock-up due to sudden spring-brake application.

Here are my tips for avoiding serious crashes arising from parking brake and emergency brake problems:

1. Fit a warning system that sounds the horn when the driver door is open and the parking brake on the truck is not applied. This should be a design rule requirement, but it is too hard for Australia to achieve this.
2. Inspect the trailer brake couplings on the truck and the trailer at every service. Keep them cleaned and lightly lubricated. The purpose is to keep them free of dirt, easily operated and free from corrosion.
3. Avoid using self-sealing bayonet air couplings. They have restricted paths and are more vulnerable to clogging than straight-through couplings.
4. With a European truck, get the parking brake control changed if necessary, so that the parking brake control cuts off the supply line to the trailer. This is a brake modification and approval by an accredited person (an Approved Vehicle Examiner) will be needed. The safest approach is to park Australian trailers on spring brakes.
5. When the vehicle is being serviced and is over the pit, apply the parking brake control and observe whether all of the spring brakes apply at the same time. Also check that they all go off equally. If not, fix it.
6. Occasionally trigger the parking brakes with the vehicle moving very slowing (under 5km/h). Experience how the vehicle behaves. The purpose is to experience a sudden park brake application in a safe manner.

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