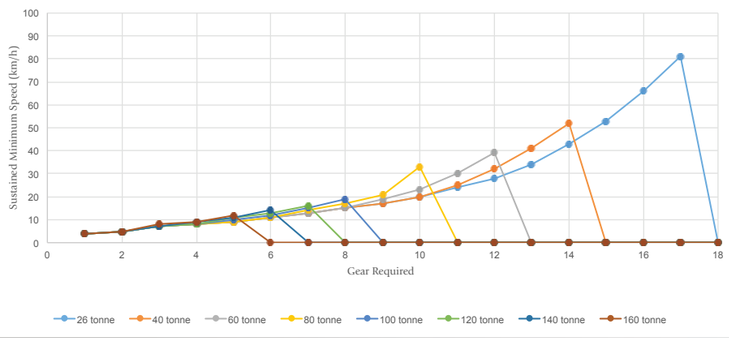
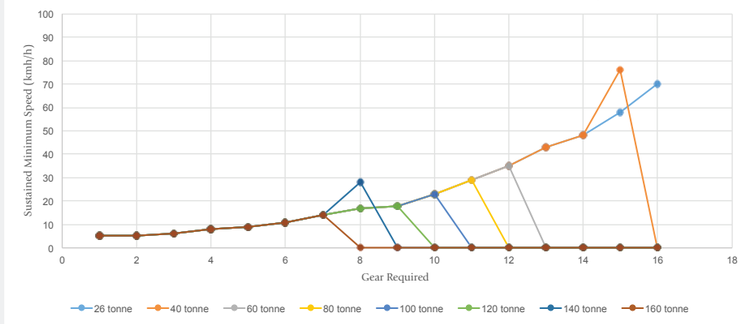
Safe downhill driving – why we need an auxiliary brake rule

One of the most dangerous situations that a heavy vehicle driver is likely to face regularly is going down a long and steep hill. The problem is obvious: The energy in the hill must be absorbed or the truck speed will run away. The capability of the foot brakes to absorb this energy depends upon them being initially cool, in good adjustment and having proven high-temperature performance. These three conditions are often not met, which makes the vehicle vulnerable to run-away on steep hills.
All brake friction material (lining or pads) will have reduced effectiveness above ~350°. Drum brakes have the added vulnerability that the brake drum will expand when it is very hot, hence additional stroke is needed from the actuators. If the brakes are not in good adjustment then the actuators on brake drums may run out of stroke, causing the effectiveness of the drum brake to be poor.
Disc brakes have better high-temperature performance than drum brakes because the disc expands when hot and so the actuator stroke required is reduced.
Further, disc brakes invariably have automatic brake adjustment and so are less likely to be out of adjustment than drum brakes. Disc brakes have their own vulnerability, which is failure when red-hot. The mass of iron in the disc brake is a lot less than in a drum and the disc pads are a lot smaller than the brake shoe. The operating temperature of the disc brake can become extremely hot faster than that of the drum brake.
Ultimately a powerful auxiliary brake is the most reliable safeguard for steep downhill descents, because it takes the load off the foot brake.
Drivers usually rely upon a powerful auxiliary brake, such as an engine brake or drive shaft retarder, to absorb most of the hill energy. Engine-brake retardation increases with engine speed, so to make the most of the available retardation, gear selection at the top of the hill is crucial.
The driver's first responsibility is to ensure a sensible starting speed of around 20km/h and gear selection to match. The driver's second responsibility is to check that the brakes are suitability cool before starting downhill. If the route leading to the descent has many hills, the brakes are likely to be hot. It is good practice to stop in a safe place at the top and check brake temperature by hand and nose.
Drivers should also have a good braking technique. If the foot brake needs to be used for speed control during the descent then the brake applications should be firm, so that all the brakes will do some work. Feathering the brake pedal is not advisable because not all brakes may be contacting. If only a few brakes are contacting then a cascading failure mode where brakes fade in sequence can occur. The firm application ensures that all brakes are doing some of the work.
Periodically slowing the vehicle with a firm brake application and then releasing the brakes for a short time is good practice.

Graph 1 - Kenworth T909 auxiliary brake performance at 7% slope .



Graph 2 - Mercedes-Benz Arocs auxiliary brake performance on a 7% slope.



The truck owner has significant responsibility for safe downhill driving, too. Firstly, brakes need to be in good adjustment. This is not the driver's responsibility. Brakes that are stroking over-centre are vulnerable to running out of stroke when very hot. Poor adjustment may not be obvious to the driver until the brakes fade. It is the owner's responsibility to have a service regime in place that prevents the brakes stroking over centre.
The second responsibility of the vehicle owner is to use genuine brake linings and pads, or otherwise friction material that has design-rule (ADR) certification status on a similar vehicle make. Satisfactory brake lining fade-performance is an ADR requirement and an owner who fits uncertified brake friction material is taking an unacceptable risk for all concerned, including the public.
Australian state and territory governments have failed to establish workable certification standards and procedures for replacement brake friction material, which has been exploited by some brake suppliers and operators. If a crash occurs at the bottom of the hill, the truck operator could be held accountable for using uncertified brake linings.
There is no Australian design rule that requires trucks to have a powerful auxiliary brake. New European heavy trucks must have an auxiliary brake as specified in Directive 71/320/EC and/or UNECE Regulation R13 (which Australia accepts but has not mandated). The European requirement is that a new heavy motor vehicle with a towing rating of 10 tonne or more to be capable of holding a speed of no more than 30 km/h on a seven per cent downhill slope (4°) for a distance of 6km (corresponding to a test time of 12 minutes) when loaded to GVM level. The foot brake must not be used. Remarkably, there is no US rule that mandates or even specifies how to rate an auxiliary brake, despite the fact that the engine brake was invented in the US.
The two graphs show the downhill speed capability of two truck models that have powerful auxiliary brakes. The slope is seven per cent and the load can vary as shown below the graphs. Graph 1 is for a Kenworth T909 with a Cummins ISX600 engine. It can hold 30 km/h in gear 12 at 100 tonne total weight. Graph 2 shows that the Mercedes Arocs with a Mercedes OM 473 (62hp) engine can hold 30 km/h in gear 12 at 100 tonne load. Both models can meet the UNECE Regulation 13 performance requirement. Both models have powerful auxiliary brakes although they are different types with different controls. The Cummins ISX600 has a powerful engine brake that has peak retardation at 2,100rpm. The Arocs has both an engine brake and a transmission retarder. Smart electronics manage the downhill speed of the Arocs and prevent the vehicle ending up in neutral due to an ill-considered gear change. The Kenworth has a manual control and it is up to the driver to get the gear selection right.
I am looking forward to an auxiliary brake rule for heavy trucks in Australia. Road safety will be better off for it.

Peter Hart
Chairman, Australian Road Transport Suppliers' Association (ARTSA)