Determining speed from braking skid marks

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Expert forensic engineers are often asked by lawyers to determine vehicle movements before, during and after a crash. These movements can be determined in a number of ways depending on the information available. A key piece information is whether any skid marks were identified and their nature and location photographed.

Vehicles can leave different types of tyre-friction marks depending on the circumstances, and it is important to distinguish between them. The two most relevant to measuring the speed of a vehicle are braking skid marks, caused by a sliding non-rotating tyre; and scuffmarks (yawmarks), made by a rotating tyre slipping sideways. This article focuses on braking skid marks and how to determine speed from the length of the mark and the surface friction.

Figure 1: Braking skid marks left by the 4WD vehicle

The speed of a vehicle at the start of the skid marks can be calculated by using the 'speed from skid equation'. This equation is often expressed as:

Where:

V = speed of the vehicle

f = coefficient of friction

g = 9.81m/s^2

d = skid distance

The co-efficient of friction is commonly referred to by crash reconstructionists as the 'drag factor'. It is expressed as the ratio of the force of friction between two bodies and the force pressing them together. The coefficient of friction varies, depending on the materials in friction with each other. For example, when a car is sliding on 'black ice' the co-efficient of friction is very low (that is, the tyre slides easily over the ice) and ranges from 0.07 to 0.20. On the other hand, a bitumen road produces a higher co-efficient (that is, the tyre does not slide on the surface easily) and can range from 0.55 to 0.8 or higher. An average value of around 0.6 to 0.7 is commonly adopted.

The formula is independent of mass; it doesn't matter whether the car weighs 500kg or 5 tonnes. Vehicles should, theoretically, brake to rest over the same distance for a given speed and coefficient of friction between the tyres and road surface (tyres can affect the results).

The skid marks for the vehicle shown in Figure 1 were approximately ten metres long. An important question in many motor vehicle accident cases is what the vehicle's speed was at the time the brakes were applied. Using the above formula we get the following:

$V = \sqrt{2 \times 2.7 \times 9.81 \times 10}$ = 11.7m/sec (or around 42 km/hr).

Naturally enough, the accuracy of this result rests entirely on how accurately the skid marks are measured and the friction co-efficient decided. For this reason, geodesic survey equipment – a pacing wheel or survey tapes – is often used to measure skid lengths.

The co-efficient of friction can be made more precise by using the vehicle involved in the incident (if it can still be driven) to carry out a skid-test at the site of the incident. Test-skidding is carried out and deceleration measured using a calibrated accelerometer. Caution is advised when vehicles and tyres are tested other than those of the vehicle involved in the collision. Skid-testing shows that alternative vehicle and tyre combinations can produce up to a 14% variation in the friction factor in dry conditions and up to 26% in the wet.

An alternative is to use a drag-sled test, which uses tyre material fixed to the bottom of a weighted mass. The mass is dragged along the road surface and the force required to drag the weight is measured, allowing the co-efficient of friction to be calculated. Other devices can also be used, such as the Munro Portable Skid Resistance Tester.

Only once all the required information is available can the vehicle's speed prior to the skid marks be calculated. ■

Notes: These calculations are simplified and apply only to the condition where a vehicle skids to a stop. Where an impact occurs before a vehicle skids to rest, others related equations need to be used.

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