Vehicle Dynamics – Theme 6: Crashes | **Factsheet 6a** |

What happens in a crash?

When a vehicle crashes, a large force is generated. This force is measured in Newtons (N) or kiloNewtons (kN) and is calculated as the mass of the vehicle times the acceleration (speed): **F = m x a**

Mass is measured in kilograms (kg) and acceleration in metres per second (m/s^2).

As an example, a car weighing 500kg crashes head on into a wall at a speed of 30 km/hour (which is equal to 30,000 metres per 3,600 seconds = $8.33 m/s^2$). The force of the crash is:

500kg x 8.33 m/s^2 = 4,165 Newtons (more than 8 times the weight of the car)

If the car was travelling at 60 km/h (equal to 60,000 per 3,600 seconds = 16.66 m/s^2), the force of the crash would be:

500kg x 16.66 m/s^2 = 8,330 Newtons (more than 16 times the weight of the car)

The force generated by the crash needs to be spent somewhere. In our example, the rigid wall will absorb very little of the force's energy, so most of it will be deflected back onto the car.

The car structure, especially the front, will start crumpling as a result of the crash force. This is good because less force will reach the car occupants. However, even if we assume that the car structure absorbs 50% of the crash energy, the driver/passengers will still be hit by a force of around 2,000 Newtons. This can do a lot of damage!

Let us now imagine that two identical cars of the same weight and travelling at the same speed, collide head on. The force created will double and will be distributed evenly on to each car. The effect of the force would be the same for each car and it would be as if each car had crashed against a rigid wall.

If, however, one car was much bigger than the other, the effect of the force would be much worse for the smaller car. This is because the proportion of the force to the car's mass would be much greater. It has been proven in crash tests that:

100kg more weight in a car-to-car impact will generate a 7% lower risk of injury for the heavier car.

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Let us now look at another scenario. Two cars, both weighing 500kg, travel in the same direction, one behind the other. The first car is travelling at 30km/h while the second at 60 km/h. When the second car hits the first, the force generated will be:

F = F2-F1 = (500 x 16.66) – (500 x 8.33) = 8330 – 4165 = 4,165 Newtons
Each car will absorb half of that force – 2,082.5 N.

This is much less than if the same cars crashed head to head:
F = F2+F1 = (500 x 16.66) + (500 x 8.33) = 8330 + 4165 = 12,495 Newtons
where each car will absorb half of that force – 6,247.5 N

As we saw, the force of a crash depends on both the weight of the vehicle(s) and the speed of travel. Drivers cannot do anything about the weight of their vehicle but they can control their speed. This is particularly important when crashes involve vulnerable road users like children, pedestrians or cyclists.

A difference of only a few miles per hour less speed can make the difference between life or death for a pedestrian who is hit by a car. At 35mph a driver is twice as likely to kill someone as they would be at 30mph.

Seatbelts can also make a huge difference to the effect of a crash on the car driver and passengers. Without a seatbelt, in a crash at 30mph, car occupants will be thrown forward with a force of up to 60 times their body weight!