BMW 5 Series (2012)

Hayden Gridley

Details

Drive away pricing - $108,864

Engine Type :	**I-4 2.0 litres**
Power :	245 hp @ 5,000 rpm (183 kW)
Torque :	258 lb·ft @ 1,250 - 4,800 rpm (350 N·m)
CO_2 emissions :	3,726 kg/year
Transmission :	8-speed automatic
Airbags :	6
Weight :	1,720 kg

Crash Test Video Clip

http://www.youtube.com/watch?v=lgO8p2cszvY

Crash Test Data

- 0-100 in 6.7s
- Top speed of 250Km/h.
- 100-0 in 13.5s
- Stopping distance 28.6m.
- Power – 183 kW
- Torque – 350 Nm

Star Ratings - ANCAP

- The Australasian New Car Assessment Program (ANCAP) gives detailed and consistent information about how well new car models protect their occupants in serious frontal and side crashes.

- The BMW 5 Series received a rating of 5 stars. This is a highly adequate level as the vehicle received an almost perfect score of 36.53 out of 37.

Active Safety

Active Safety describes systems that use an understanding of the state of the vehicle to both avoid and minimise the effects of a crash.

1. Good visibility from driver's seat – windows, mirrors, lights, wiper and demisters all enhance driver vision by increasing the driver's field of sight.
2. Low noise level in interior – little noise within the vehicle improves the driver's ability to better focus on the traffic situation.
3. Legibility of instrumentation and warning symbols – the more audible and effective that a vehicle's controls can be the less distracting and potentially dangerous it is for the driver.
4. Early warning of severe braking ahead – alerts the driver to dangerous nearby obstructions by giving off an audible alarm.
5. Head up displays – project the car's current speed into the driver's direct field of vision on the windscreen.
6. Night vision – sees in the dark and identifies pedestrians.
7. Good grip – allows for better vehicle control during slippery conditions.
8. Anti-lock braking system - ABS works by releasing the brakes momentarily at the point of wheel lock up. This happens very fast and helps the driver keep control of the car.
9. Electronic Stability Control – Corrects over/under steering, stabilises the car during sudden movements and improves handling on unmade roads.
10. Chassis assist – monitors the framework of a vehicle.

Active Safety (continued)

11) Intelligent speed adaptation – constantly monitors vehicle speed and the local speed limit on a road and either warns the driver to reduce the speed or intervenes and reduces the speed itself.
12) Brake assist – increases braking pressure in an emergency situation.
13) Traction control – optimizes grip and stability on the road during acceleration by measuring wheel rotation. If one wheel loses traction and starts spinning faster than others, the system stops wheel spin by reducing engine power or temporarily applying brakes to the wheel. The wheel then regains traction and the vehicle can accelerate smoothly.
14) Collision warning/avoidance – a system of sensors within a vehicle which warn the driver to any dangers which may lie ahead.
15) Four-wheel drive – enhances traction. The engine's power is used on all of the vehicle's wheels, so traction and steering forces are spread more evenly amongst the tyres.
16) Advanced Driver assistance systems – help driver in the driving process with various aspects such as parking, blind spot detection and driver drowsiness detection.
17) Autonomous cruise control system – it controls the vehicle based on on board-sensor information.
18) Adjustability and comfort - A manual or power adjustable driver's seat improves safety by making the driver more comfortable. It also ensures that any sized driver has good visibility.
19) Electronic brake-force distribution – applies more or less braking pressure to each wheel in order to maximise stopping power whilst maintaining control of the vehicle.
20) Adaptive headlights – cast their beam in the direction of the road's curve and ensure better visibility and more safety during night drives on winding roads.

Passive Safety

In the event of a crash, passive safety features are created to prevent or minimize injury to both the driver and any passengers. Some features help absorb crash forces; some restrain occupants from colliding with the vehicle's interior, and others prevent objects inside the vehicle from hitting the driver or passengers.

1. Padding and edges – the dashboard, doors, roof, sun visors, mirrors and pillars should all have thick energy-absorbing padding with no sharp edges exposed.
2. Crumple zones – This is the part of the car which is designed to be crushed in the case of an accident to slow down the speed of the vehicle at a safer rate.
3. Safety cages – diverts and dissipates crash energy, increasing the occupants stopping distance as much as possible.
4. Air conditioning - can improve comfort and reduce fatigue, especially during long trips in hot weather.
5. Automatic transmission - reduces fatigue by freeing you from constant gear changing in urban or hilly conditions and allows you to give more attention to other driving tasks.
6. Frontal impact protection – This feature works by increasing the occupant's stopping distance in the case of a head-on collision.

Passive Safety (continued)

7. Side impact protection - This feature works by increasing the occupant's stopping distance in the case of a side-on collision.

8. Seat belts – are designed to keep you inside the car. They also reduce the risk that you or your passengers will collide with any parts of the car. Seatbelt warning devices help the driver and passengers to remember to buckle up.

9. Load space barrier - separates the passenger area from the back storage area/boot. These are essential for station wagons. In a crash, even light objects can become deadly projectiles if not properly restrained.

10. Front air-bags – lower the chance of fatal head injuries. They're designed to stop your head hitting the dashboard, steering wheel and windshield.

11. Side curtain airbags - protect your head from hitting the side of the car. They can stop you being injured if your car rolls over.

12. Seats – an adjustable driver's seat improves safety by making you more comfortable. It also ensures that any sized driver has good visibility.

Passive Safety (continued)

13. Head restraints - are extensions of the car's seats that limit head movement during a rear-impact crash, thus reducing the probability of neck injury. It is important that they're adjusted to a suitable height to help minimize neck and whiplash injuries in a crash.

14. Flame resistant materials – slow the spread of fire.

15. Correctly positioned fuel tanks – a safe fuel tank location improves the prevention and protection of fire.

16. Over-speed warning devices - An over-speed warning device will warn you when you exceed the speed limit.

17. Knee bolster – an energy absorbing crushable barrier below the dashboard which stops an occupant's knees from dangerous contact with nearby hard surfaces, lessening the severity of leg injuries to front seat occupants.

18. Cruise control – helps to reduce fatigue during long journeys.

19. Steering wheel - adjustable steering wheels allow different-sized drivers to position the steering wheel for comfort and safety, allowing the instrument panel to be visible at all times.

20. Daytime Running Lights – these turn on automatically when you start your car. Using lights during the day makes you more visible to other road users.

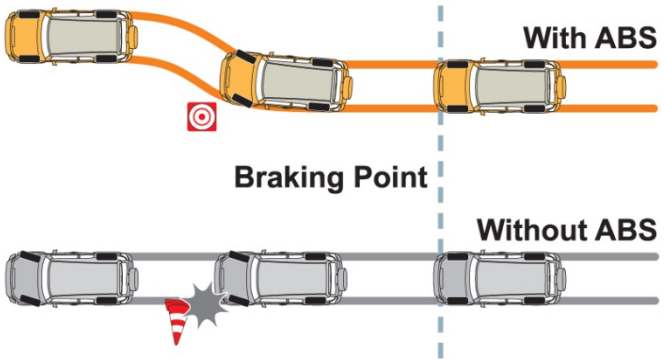
5 Active Safety Features

1) Braking Systems (ABS):

The purpose of anti-lock brakes is simple. A skidding wheel has less traction than a non-skidding wheel. If a car is stuck on ice, the wheels are spinning and there is no traction. By keeping the wheels from skidding while you slow down, anti-lock brakes benefit you in two ways: You'll stop faster, and you'll be able to steer while you stop.

There are four main components to an ABS system:

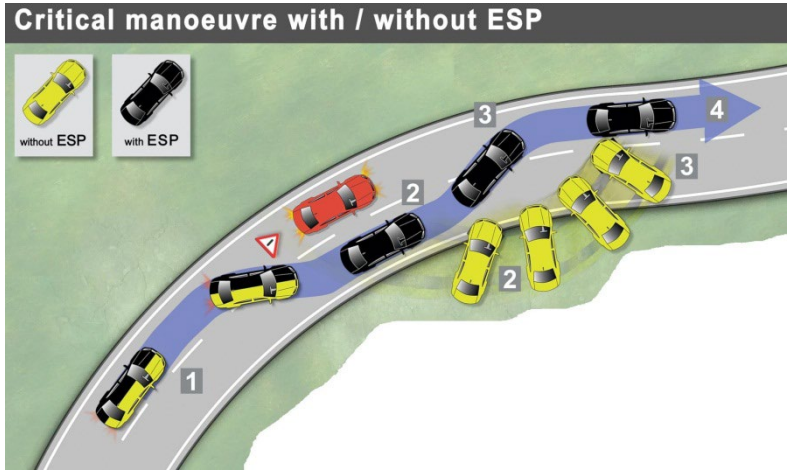
- Speed sensors
- Pump
- Valves
- Controller



5 Active Safety Features

2) Electronic Stability Control:

If the ESC system detects that the car is swinging too far (or not enough), it springs into action to assist. ESC can activate one or more individual brakes, depending on which wheel can increase driving safety the most, and control the throttle to lessen the speed at which the car is travelling. The sensor looks for differences between the direction of the steering wheel and the direction the car is headed; the car's computer then makes the necessary corrections to bring the vehicle's direction of travel in line with what the driver wanted.



5 Active Safety Features

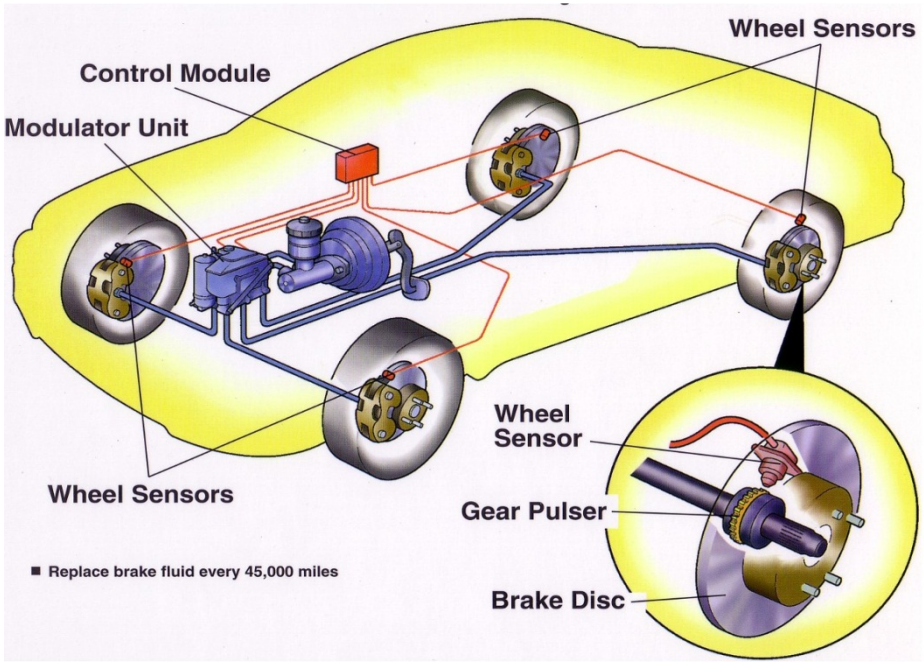
3) Head up displays:

Heads-up display (HUD) systems can project information onto the windshield. It tells you where to turn, notifying you of lane markings, identifying how close the car in front of you is and even give you restaurant information all right in front of your eyes - and while you're actually able to see those objects or places.

5 Active Safety Features

4) Traction Control:

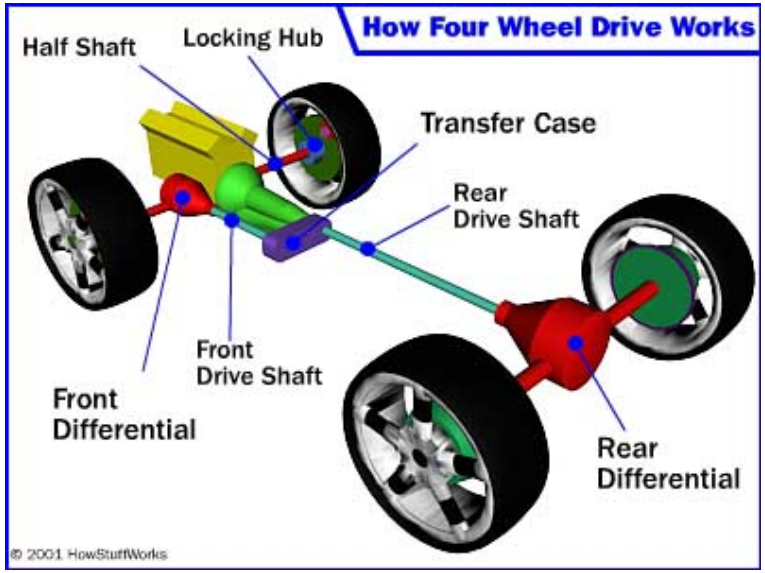
Traction control is basically an anti-lock braking system in reverse. Anti-lock brakes prevent the wheels from locking up when the car is decelerating. Traction control keeps the wheels from locking up or skidding when the car is accelerating.



5 Active Safety Features

5) Four-wheel drive

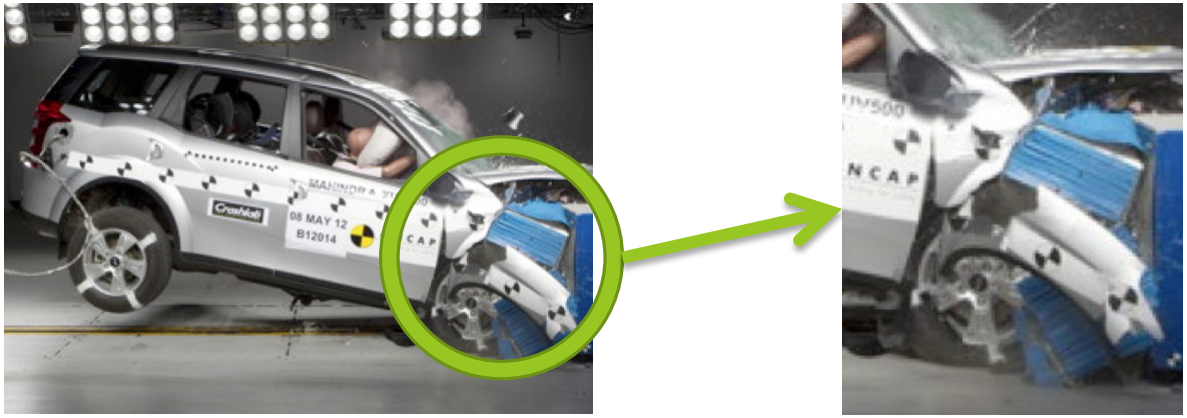
Four-wheel drive powers all four wheels only when the 4WD mechanism is engaged. Typically, these systems power the rear wheels during ideal weather conditions to reduce the wear on the drive train and improve fuel economy. However, when four wheel drive is engaged, engine power is transferred to the front wheels as well as the rear. In a “part time” four wheel drive vehicle, the engine's power is transferred into a transfer case that is mounted to the rear of the transmission. The transfer case then divides the torque evenly between a front and rear driveshaft. The drive shafts are connected to both differentials (front and rear), which divides power to each wheel.



5 Passive Safety Features

1) Crumple zone:

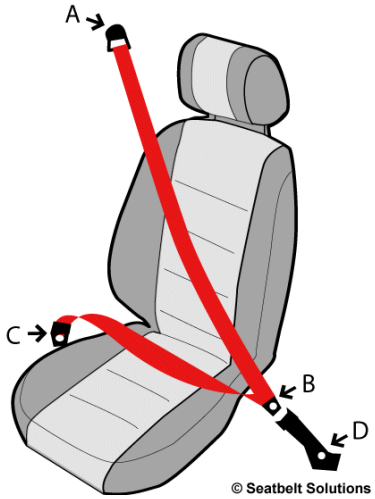
A crumple zone is designed to deform upon impact so that the energy from the crash is transferred into the body of the car, rather than into the body of the occupants. It is also designed for minimised deformation of the cabin area. Tis achieved by strengthening the inner cabin area of the design and making the outer body parts 'softer'. This sort of design helps the speed differential (the difference between the car's speed before the impact compared to the sudden decrease in speed on collision) so that an occupant's motion is arrested and they aren't thrown through windows or smashed against the car's interior. In a secondary sense it also helps slow down any accident, which in turns helps occupant safety and driver recovery.



5 Passive Safety Features

2) Seat belts:

When accidents occur, several systems incorporated in the seat belt assembly go into operation simultaneously. In less time than it takes for a person to blink an eye, the seat belt system goes into action to control the energy load the occupant endures on impact. By retracting some webbing as the collision is occurring, the pretensioner enhances the protective functions of the belt by removing some slack and helping restrain the passenger. The load limiter absorbs and softens the load on the occupant as the passenger moves forward due to inertia. In the latest motorised seat belts, there are also functions to warn the driver, as the seat belt motor gives a tug on the belt, that there is an immediate dangerous situation. (a pre-impact warning).



5 Passive Safety Features

3) Air-bags:

There are three parts to an air-bag. First, there is the bag itself, which is made of thin, nylon fabric and folded into the steering wheel or the dash board. Then there is the sensor that tells the bag to inflate. It detects a collision force equal to running into a brick wall at 20kmh.

Finally, there is the inflation system. Air bags are actually inflated by the equivalent of a solid rocket booster. Sodium azide and potassium nitrate react very quickly to produce a large pulse of hot nitrogen gas. This gas inflates the bag, which literally bursts out of the steering wheel or dashboard as it expands. About a second later, the bag is already deflating (it has holes in it) in order to get out of your way.

5 Passive Safety Features

4) Automatic transmission:

Just like a manual transmission, the automatic transmission's primary job is to allow the engine to operate in its narrow range of speeds while providing a wide range of output speeds. Without a transmission, cars would be limited to one gear ratio, and that ratio would have to be selected to allow the car to travel at the desired top speed. If you wanted a top speed of 180kmh, then the gear ratio would be similar to third gear in most manual transmission cars. When driving a manual transmission car using only third gear, you'd quickly learn that there is almost no acceleration when starting out, and at high speeds, the engine would be screaming along near the red-line. A car like this would wear out very quickly and would be nearly undriveable. So the transmission uses gears to make more effective use of the engine's torque, and to keep the engine operating at an appropriate speed. When towing or hauling heavy objects, a vehicle's transmission can get hot enough to burn up the transmission fluid.

5 Passive Safety Features

5) Daytime Running Lights:

A Daytime Running Light is an automotive lighting device on the front of a motor vehicle, installed in pairs, automatically switched on when the vehicle is moving forward, emitting white, yellow, or amber light to increase the visibility of the vehicle during daylight conditions.

Acceleration

$A = (v-u)/t$ $= (27.7778ms-0ms)/6.7s$ $= 4.15ms^{-2}$

$S = ut + ½at^2$ $= (0)(6.7) + ½(4.15)(6.7)^2$ $= 93.15m$

$V^2 = u^2 + 2as$ $= (0) + 2(4.15)(400)$ $= 3320$
$v = 57.62m/s$ $= 207.43km/h$

$V^2 = u^2 + 2as$ $= (0) + 2(4.15)(1000)$ $= 8300$
$v = 91.10m/s$ $= 327.98km/h$

This speed is not possible as the vehicle's top speed is around 250km/h. The car would probably begin to overheat after sometime; most likely causing damage to the engine. This is because the engine can only endure a certain amount of RPM before it begins to heat significantly.

Kinetic Energy

$KE = \frac{1}{2}(1730kg)(100kmh)^2 = 8650000\ J = 8650\ kJ$

$KE = \frac{1}{2}(1730kg)(27.77ms)^2 = 667438.27\ J$

Deceleration

Mass = 1730kg
Braking distance = 28.6m

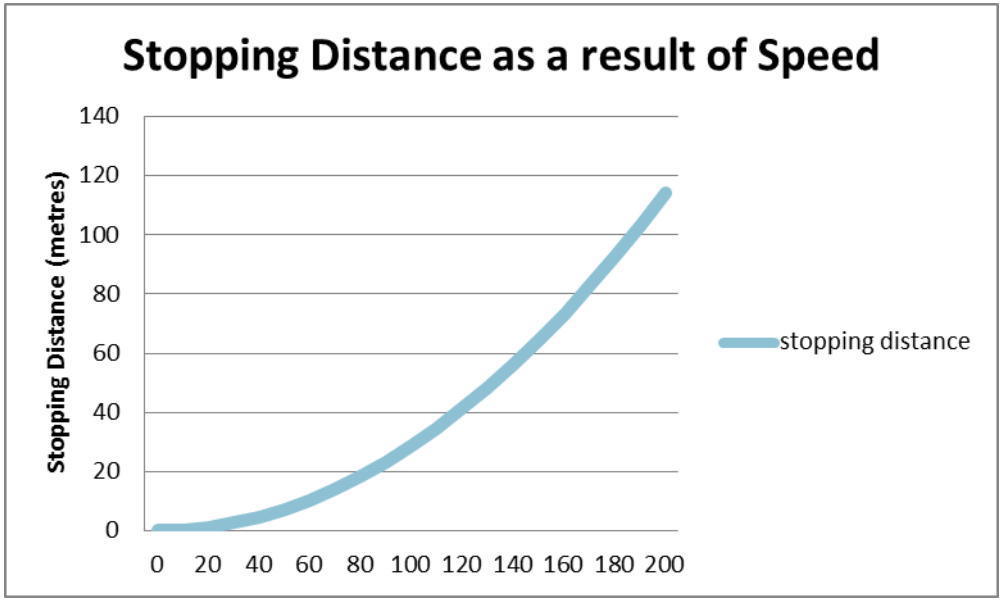
$D = (27.7778-0)/13.5 = -2.06\ ms^{-2}$

$1730 \times -2.06 = -12814.82\ N$

This force is provided by friction.

Stopping Distance (Charts)

Speed (km/h)	Speed (m/s)	Stopping distance
0	0	0
10	2.777777778	0.285779607
20	5.555555556	1.143118427
30	8.333333333	2.572016461
40	11.11111111	4.572473708
50	13.88888889	7.144490169
60	16.66666667	10.28806584
70	19.44444444	14.00320073
80	22.22222222	18.28989483
90	25	23.14814815
100	27.77777778	28.57796068
110	30.55555556	34.57933242
120	33.33333333	41.15226337
130	36.11111111	48.29675354
140	38.88888889	56.01280293
150	41.66666667	64.30041152
160	44.44444444	73.15957933
170	47.22222222	82.59030636
180	50	92.59259259
190	52.77777778	103.166438
200	55.55555556	114.3118427



Stopping Distance (continued)

At 200 kmh^{-1}, the stopping distance becomes 114 metres, more than four times greater than the 28 metre stopping distance for 100kmh^{-1}.

At 110kmh^{-1}, the stopping distance is 6 metres greater than a car travelling at 100kmh^{-1}.

KE = ½mv^2 = ½(1730kg)(30.6ms)^2 = 807600 J = 807.6 kJ

807600-667438.27 = 140162 J The crumple zone has to absorb an extra 140162 J.

KE = ½mv^2 = ½(1730kg)(55.6ms)^2 = 2669753 J = 2669.8 kJ

2669753-667438 = 2002315 J The crumple zone has to absorb an extra 2002315 J.

Australian Trends

From the 1970's to 2007, there has been a significant downward trend in Australian road deaths.

Further initiatives for road toll reduction:

- Graduated Licensing Schemes for young drivers.
- Static and mobile driver testing for alcohol and drugs.
- Mandatory alcohol interlock program.
- The introduction of a 50km/h default speed limit in urban areas.
- A network of safety cameras at high risk intersections.

Australian Trends (continued)

One example of a further initiative to reducing the road toll further would be to create a more consistent road safety education system for L and P plate drivers.

Young people still represent a disproportionate number because they haven't had enough experience in independent driving as it takes many years to develop consistent driving skills.

Compared to female drivers, male drivers are significantly more prone to both road accidents and fatalities. This is primarily due to drug and alcohol related problems.

Further initiatives for this would include increased driving age restrictions and an increased awareness of the importance of safe driving.

Highly Motorised Countries

Portugal has the most fatalities at 21.1 deaths per 10000 motor vehicles.

Iceland has the least fatalities at 3.7 deaths per 10000 motor vehicles.

Compared to the UK and Japan, Australia has far more deaths at 10.8 with Germany almost the same at 10.7. Fatalities in France (13.8) and the USA (15.8) are even worse; both more than double the fatalities of the UK.

Victoria's special mention is due to the significant reduction in fatalities over the last few years as it holds an important message about the important of strict authority.

The safest place to be in the car is the rear as each of the countries show 4% or less of the total Fatalities being due to this. As for the most dangerous place in the car, in Germany it is the side while France, Japan, UK and USA all clearly state the front to be the worst place.

I think the rear of a vehicle is the safest place for two reasons. Firstly, almost always protect from behind by the boot of the car, a very effective crumple zone when necessary. And secondly, it's generally not very likely to be in a dangerous collision as vehicles don't reverse very fast and head on collisions are easily far more dangerous than if one car simply drives into the back of another. The front is the most dangerous part of the car mainly because drivers often crash into objects in front of them due to fatigue or drink/driving.

Highly Motorised Countries (continued)

It would be similar in Australia; head-on collisions are highly common as drink/driving is a very common and fatal issue.

1. France and Germany have very similar fatalities in each aspect, possibly due to similar issues and factors which cause such deaths.
2. In Japan, cars aren't a very common mode of transport as many accidents involve vehicles other than that, most commonly pedestrians, suggesting that there is a very large population in comparison to Germany which has far more vehicle deaths.
3. In the US, when comparing car fatalities to bicycle and motorcycle fatalities, the chart suggests that bicycles and motorcycles aren't very common modes of transport, resulting in a far smaller percentage of deaths.
4. In the United Kingdom, there is a far greater risk in walking places then riding on a bike, maybe due to a lack in safe road and railway crossings for pedestrians.
5. In the US, pedestrian, bicycle and motorcycle deaths combined are far less than fatalities due 'other' road users, showing that there is a prominent cause of fatalities which is uncommon to other countries as they average less than 7% of 'other' deaths.

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