

Understanding Auto Bumper Isolators in Vehicle Crashes

1. What is an automobile bumper?

A device typically found in the front and rear of a motor vehicle that offers some measure of protection to certain auto components from external impacts.
2. What is the purpose of the bumper?

Bumpers are designed to reduce the amount of *property damage* to the vehicle. They are not designed to offer protection to the vehicle occupants.
3. What is the bumper designed to protect?

According to US federal regulations, the purpose of bumpers on US automobiles is to maintain the functional integrity of the exhaust, fuel, cooling and lighting systems, as well as the ability to fully open the trunk, hood and doors following a 2.5 mph (current standard) vehicle impact.
4. Do the bumpers offer any protection to the occupants of the vehicle in collisions?

In typical low impact collisions, bumpers offer minimal, if any, protection to the vehicle's occupants. In fact, there is no scientific evidence that most bumpers reduce the incidence of occupant injuries. However, the federal mandating of the placement height of bumpers from the ground on passenger cars can help minimize certain injuries to *non*-occupants that are struck by these vehicles.
5. Is the amount of bumper damage from an impact a good predictor of occupant injury?

The auto defense industry often, knowingly or otherwise, misconstrues the meaning of the degree of bumper damage in low impact collisions. One of the most common ploys is to misuse the current bumper assemblies rating of 2.5 mph for front and rear vehicle collisions. This rating is frequently misrepresented as *the threshold of damage to the bumper itself*. This is definitely not the case. The fact that a current bumper assembly must meet a 2.5 mph standard set by the federal government does not in anyway imply that this velocity represents the threshold for damage to the bumper. It simply means that the bumper is designed to prevent damage to the critical components of the vehicle identified above at delta Vs of ≤ 2.5 mph. Research from actual vehicle crash testing has shown that many vehicle bumpers can withstand repeated impacts of delta Vs near 10 mph with only cosmetic damage. This delta V is significantly beyond the established threshold for occupant injury. As you may be aware, the threshold for occupant injury is approximately a delta V of 4.5 mph.
6. What is a bumper made of?

A bumper can be made of steel, aluminum, rubber, plastic, or composite. Some automobile bumpers use energy absorbers or brackets, and others are made with a foam cushioning material. Many passenger vehicles use an energy absorber unit called an "isolator."
7. What is a bumper isolator?

A bumper isolator is a specially designed unit that slightly dampens the force of the impact up to a varying delta Vs, depending on the type of isolator used.
8. How does a bumper isolator work?

An isolator is essentially a small shock absorber that mounts between the frame and bumper. Its purpose is to reduce the amount of property damage to vehicles in low speed impacts. An isolator *typically* uses a gas-filled system piston assembly. Upon impact, the gas is compressed, acting primarily as a spring. With increasing compression, a metering device allows movement of oil out of the chamber. This oil can move in both directions, thereby providing viscous fluid damping. Such fluid dynamics allows the bumper to rebound less forcefully than would occur with a simple spring. It should be noted that some less expensive isolator units on older vehicles actually employ a spring set-up, and these provide more acceleration post impact.
9. Do all cars use bumper isolators as part of their bumper isolator assemblies?

Some newer cars do not have isolators. Instead, many of these vehicles are equipped with corrugated units that deform in a controlled fashion when sufficiently impacted. These units commonly consist of polyurethane or polystyrene viscoelastic systems. Such units are typically "one-shot" struts that leave no definitive means for determining the impact force. This makes such devices of little value when estimating the delta V of the collision.
10. How can a bumper isolator be used to accurately estimate the delta V in auto impacts?

From the impact of the collision, the piston is forcefully moved within the cylinder of the isolator unit. This causes easily discernible marks on the piston unit. Totally enclosed isolators must be taken apart to detect these marks of displacement. Researchers have tested these devices and have determined the forces needed to compress these pistons to varying degrees. This data is readily convertible to delta V equivalents, allowing one to estimate the target (i.e., struck) vehicle's delta V in low impact cases with reasonable accuracy.
11. Are there limitations to the use of isolator compression evidence in estimating delta V?

Yes, there are limitations to this method. No approach, except for careful, direct measurements, is without limitations. Here are a few examples of potential problems: Isolators on older passenger cars may become frozen and therefore nonfunctional. Since these devices will not compress, rational estimates of delta V are not possible. Isolators with tapered pistons do not leave marks when compressed and therefore offer no basis for analysis. If the direction of impact is oblique, more energy is needed to compress the isolators, making delta V analysis more difficult. Evidence of *maximum* compression of any isolator piston can only be used to provide a rational estimate of the *minimum* delta V from the collision, not the maximum.