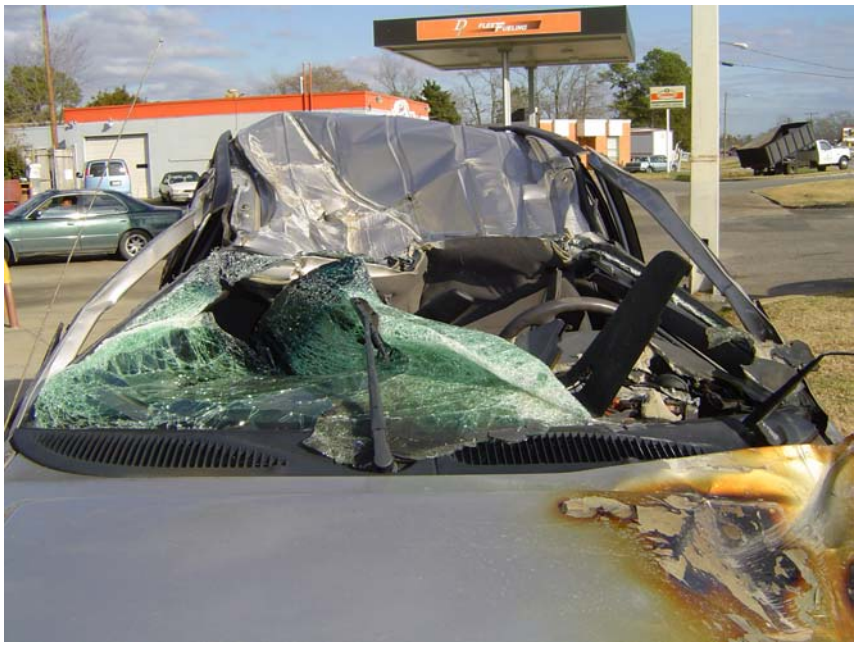
Safety Briefing on Roof Crush



How a Strong Federal Roof Crush Standard Can Save Many Lives
&
Why the Test Must Include Both Sides of the Roof

~ Public Citizen ~
www.citizen.org

The Importance of Far Side Safety in Rollover Crashes

- The current National Highway Traffic Safety Administration (NHTSA) static test applies a platen on only one side of the vehicle.
- Yet a NHTSA study from July 2004 (Roof Crush Analysis Using 1997-2001 NASS Case Review) stated "[g]enerally, it was found that roof deformation was most severe on the side of the vehicle opposite the side that makes first contact with the ground."
- Of the 6,000 to 7,000 of people seriously injured or killed by roof crush every year, NHTSA officials have said that only a small number of lives (between 50 and several hundred) would be saved by the new standard.
- A slight upgrade of the one-sided test would, in fact, be very ineffective in saving lives.

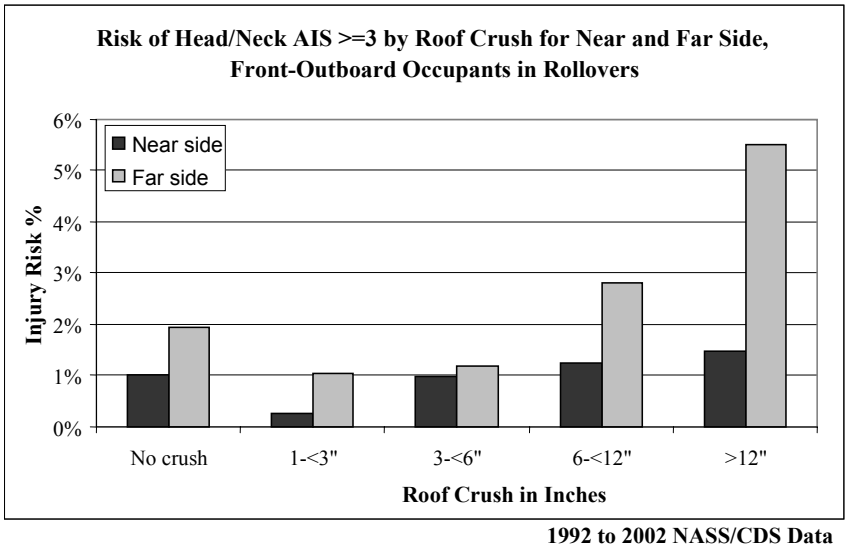
The Problem of Far Side Impacts:

In rollovers the roof is mainly crushed and people are seriously injured on the FAR side, opposite to the direction of roll (or NEAR side).

Passenger (far side) injury

Driver (far side) injury

Far Side Occupants at Much Higher Risk from Roof Crush than Near Side

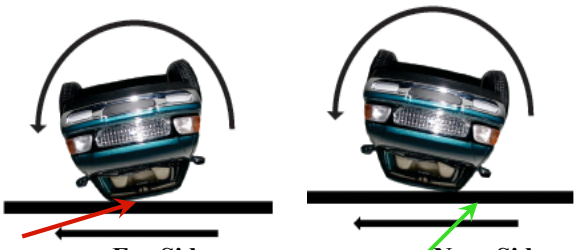


1992 to 2002 NASS/CDS Data

- The second, far side impact in a rollover crash is different from the first impact in a number of ways. It has a different and more severe pitch angle and greater roll angle. The strength provided by the windshield and its bonding is gone after the first impact when both break, meaning that the roof is substantially weakened when the second or far side impact occurs.

Road Contact Resultant Roof Forces

are similar in pitch but more lateral on the far side than on the near side



Far Side **Near Side**

Far side roof strength is reduced as much as 30 percent by near side windshield breaks, plus an additional 40 percent by the more lateral loading. [11]

- For this reason, a one-sided test fails to diagnose a major cause of injury to occupants in rollovers, and far side roof strength is far more important than near side. **While near side tests pass vehicles that can support 1 ½ times the vehicle's weight in a static test, on the far side in a sequential test, many vehicle roofs cannot actually support even the weight of the vehicle. This is the reason for roof collapse in actual rollover crashes.**
- In addition, a strong prevents breakage of the glass. Dynamic testing confirms that if the roof crushes less than 4 inches, the side window glazing is generally preserved, limiting ejection. In images of a Volvo XC90 in a multiple roll dynamic test available on the Public Citizen Web site (www.citizen.org), the windows remain totally intact, even after multiple rolls.
- A one-sided test would not measure the roof crush on the far side in the images below:

Fatal or Serious Injury Rollovers with the **Driver Side Leading, Passenger as Far Side**

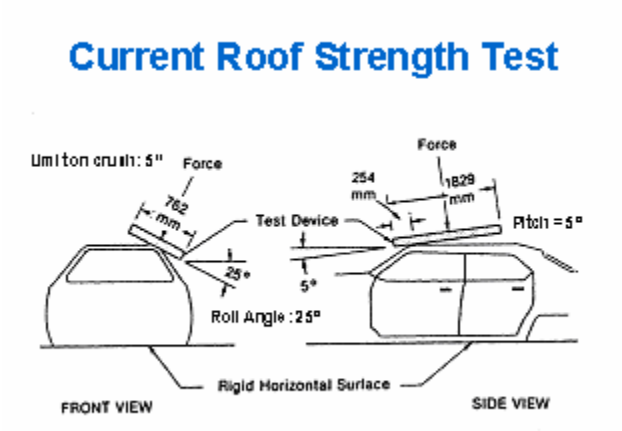


Fatal or Serious Injury Rollovers with the **Passenger Side Leading, Driver as Far Side**

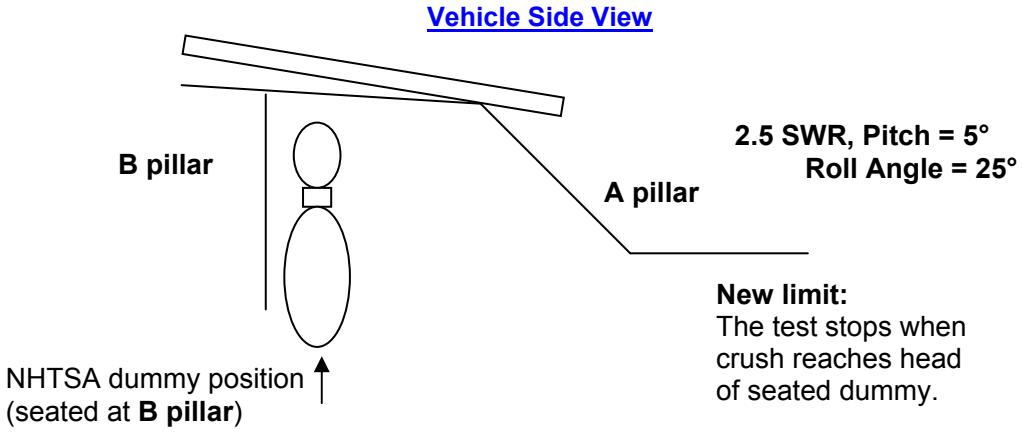


The Importance of A-Pillar Strength in Rollover Crashes

- The current National Highway Traffic Safety Administration (NHTSA) static test applies a large platen on only one side of the vehicle's roof at a **pitch angle of 5°**, and a roll angle of 25°. The roof must be strong enough that with a force of **1.5 times** the vehicle's weight pushing on it, it does not crush more than 5 inches. The 1.5 times figure is called the Strength-to-Weight Ratio, or SWR.



- Based on agency officials' statements and reports it appears NHTSA is planning a minimal change to the standard, **increasing the Strength-to-Weight-Ratio (SWR) to about 2.5** and permitting the roof to crush until it contacts a dummy's head. The pitch angle and roll angle would not change, and the test would also still be performed on only one side of the roof.

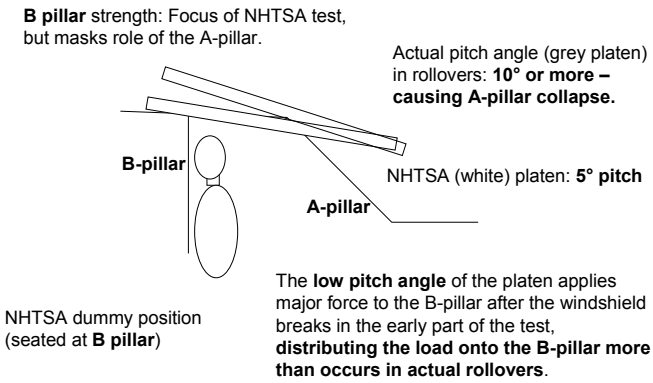


- NHTSA officials have said that **only a small number of lives – 50** – would be saved by the new standard, although roof crush in rollover kills 6,000 to 7,000 people a year, and **27,000 people annually are killed or seriously injured in rollover crashes.** This type of NHTSA rule would save few lives, in part because **data show the average roof strength of on-road vehicles is already 2.3 SWR**, and that many, if not most, vehicles now made can meet the anticipated NHTSA proposal. NHTSA tests in 2003 of recent models found that 8 of 10 vehicles would pass the anticipated new standard.

- A major reason for the low benefits is that NHTSA's test conditions permit a very weak A-pillar (beside the windshield). **In addition to testing only the near side of the vehicle, the NHTSA test is unrealistic when compared to actual rollovers for three critical reasons:**

  1) **It uses the wrong pitch angle — 5°**. SUVs and pickups are significantly front-heavy and typically pitch forward during a rollover crash at an angle of 10° or even more — not 5°. In the test, the low pitch angle for the platen allows the B-pillar (beside the dummy's shoulder) to take up the load, whereas in an actual rollover the force is concentrated on the more forward A-pillar that holder the windshield.

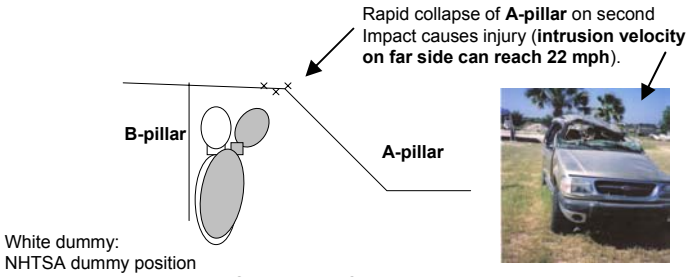
Load Placed on B-Pillar in Test Conceals A-Pillar Failure



  2) **The dummy's head position is unrealistic** — In the NHTSA test, the test dummy's head is positioned straight up, where as in actual rollover crashes the occupant's head is tossed forward — essentially in-line with the collapsing A-pillar section of the roof.

  3) **The test does not measure the speed of the roof's intrusion** — When a weak A-pillar buckles, it collapses into occupant survival space at a speed inflicts injury.

NHTSA Dummy Position Focuses Incorrectly on B-Pillar Strength, Ignores Intrusion Velocity



- A weak A-pillar also allows side window glass to break, **allowing occupants' bodies, head and arms to be ejected through the side openings**, with devastating results. Due to all these factors, the NHTSA test is very poor at predicting the performance of vehicles in real world rollover crashes. **A dynamic test which simulates actual rollovers is needed.**

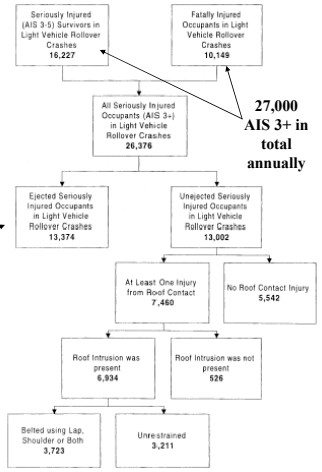
Roof Strength is Critical to Ejection Risk in Rollovers

- **Ejection is the most dangerous possibility for an occupant caught in a rollover crash.** Between 1992 and 2002, *two-thirds* of people killed in rollovers were partially or fully ejected, and 20 percent of these were belted. There is no existing standard for belt performance in rollovers. The total number of people seriously injured or killed in rollover crashes in a single year is 27,000.

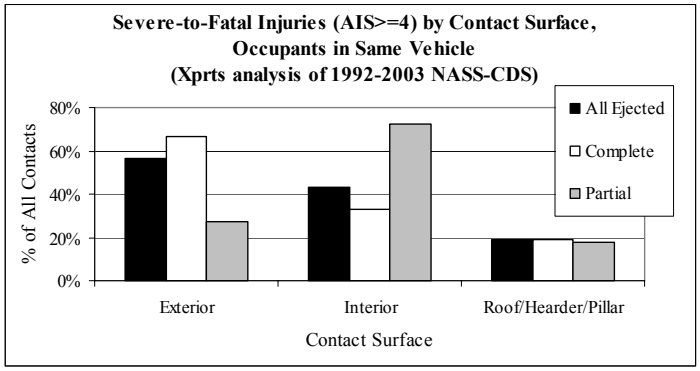
- **NHTSA ignores roof-strength/ejection link.** NHTSA's roof crush analysis excludes ejection risks. Yet NHTSA data shows *45 percent of partially or fully ejected occupants contacted the inside of vehicle, including the roof, prior to ejection.*

Roof Strength/ Ejection Relationship Ignored

NHTSA Underestimates Roof Strength Benefits:
Serious Injuries Analysis
(from Request for Comments)



NHTSA excludes ejected occupants, and assumes that occupants **were not injured by roof crush prior to ejection**.



- **Roof strength is critical to ejection risk in a rollover:** When a weak roof collapses, the supporting pillars deform, warping and shattering the windshield and side windows and unlatching the doors. This opens many potential portals through which occupants can be ejected.

- **Centrifugal forces exacerbate risk:** The centrifugal forces of the rolling violently pull occupants outside of the vehicle, and without pretensioners, belts are too slack to hold occupants in place.

- **Industry documents prove ejection-roof strength relationship:** In 1982, General Motors began a study of rollover occupant ejection and roof strength. GM engineer Ivar Arums found that the roof lost about one-third of its strength when the bonded windshield broke. Arums estimated a 23 percent reduction in ejections with tempered glass and a stronger roof. However, *GM failed to tell NHTSA about these results.*

** ALTHOUGH IT MAY BE TECHNICALLY CHALLENGING TO MITIGATE EJECTION BY DEVELOPING ALTERNATIVES TO GLAZING MATERIALS IT SHOULD BE KEPT IN MIND THAT PARTIAL EJECTION REDUCTION AND POST ACCIDENT EGRESS/ACCESS ARE SIGNIFICANT ASPECTS OF VEHICLE DESIGN.

** THEREFORE IT IS NECESSARY TO TEST THE STRUCTURE AVAILABLE TO RETAIN THE GLAZING AS WELL AS TESTING THE OCCUPANT RETENTION CAPABILITIES OF THE GLAZING .

- **Dynamic tests show the adequate roof strength prevents window breakage:** Testing with the use of the dynamic rollover testing device the Jordan Rollover System (JRS) indicates that if the roof does not distort more than 3 or 4 inches, the rollover will not break the windows, and occupants cannot be ejected.

Summary: Roof Strength is Backbone of Rollover Safety, Dynamic Tests Needed to Reflect Actual Rollover Risks

- **Far Side Occupant Risks Ignored by NHTSA:** In rollover crashes, the roof is mainly crushed and people are seriously injured on the far side. This impact occurs at a more severe pitch and roll angle, after the roof has been substantially weakened by windshield breakage from the first impact. NHTSA's current static test is a one-sided test, *and fails to measure roof crush or occupant risk on the far side.*

- **Weak A-Pillars Ignored by NHTSA:** NHTSA's test conditions permit a very weak A-pillar (the pillars beside the windshield). SUVs and pickups are significantly front-heavy and typically pitch forward during a rollover crash at an angle of 10° or even more — not 5°, as in the NHTSA test. The low pitch angle in the test allows the B-pillar (behind the dummy's shoulder) to take up the load, whereas in an actual rollover the blow is concentrated on the A-pillar. Also, in NHTSA's test the test dummy's head position is unrealistic, positioned straight up instead of tossed forward as it would be in an actual rollover crash. Finally, NHTSA's static test ignores the speed of the A-pillar collapse, which is up to 22 mph — fast enough to injure or kill an occupant.

- **Ejection/Roof Strength Relationship Ignored by NHTSA:** A vehicle's roof strength is closely tied to the risk of ejection during a rollover. If the roof is too weak, the supporting pillars deform and collapse when the vehicle's roof strikes the ground in a rollover, warping and shattering the windshield and side windows and unlatching the doors. This opens many potential portals through which occupants can be ejected.

- **An effective roof strength test would prevent thousands of deaths and serious injuries.** A standard that limits crush to about 4 inches in a dynamic test, such as the dolly rollover which is currently an optional test part of Federal Motor Vehicles Safety Standard 208, would reduce ejections at least 50 percent – preventing at least 6,500 deaths and serious injuries, or 125 per week. Roof intrusion injury would also be greatly reduced, preventing another 100 deaths and serious injuries each week and bringing the total number to 10,000 each year. In order to minimize rollover deaths, a vehicle needs a stronger roof, in addition to advanced window glazing and rollover-sensitive belt and airbag systems — as is featured on Volvo's XC-90 SUV.

- **NHTSA should make the now-voluntary FMVSS 208 dolly rollover test mandatory.** And at a minimum, a two-sided test with greater pitch and roll angles should be required by the agency, and verified with dynamic testing.