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Lightweight plastic foams can add strength to automotive body cavities and increase occupant safety in vehicles

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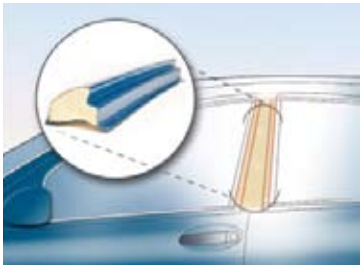
- Filling thin-walled, hollow structures in vehicles with rigid, plastic foam can improve the structural strength of the vehicle without adding significant weight.[1]
- Foam is injected into hollow cavities of the body sections such as the pillars, cowl, and rocker panels. It assumes the shape of the cavity and remains intact over the life of the vehicle, blocking noise, air, and water paths.[1]
- Structural foam can also provide stiffness to hollow body sections and joints. A bending test found that a tube filled with a low-density foam of 3 pcf (pounds per cubic foot) provided nearly twice the bending strength of the unfilled tube.[1]
- Plastic foam can be used to help increase safety in rollover accidents by enhancing the structural support necessary to prevent roof crush; a structural failure that kills 10,000 people on the roads every year.[2]

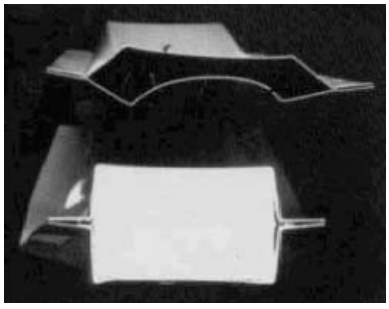


The upper portions of the B-pillars in this vehicle were filled with rigid plastic foam for better roof crush resistance in rollover crashes.

- A roof crush simulation aimed at evaluating the effectiveness of foam found that filling the B-pillar ring, B-pillars, and rear roof header with foam raised the strength of the roof by 72%, as compared to hollow steel components. In fact, filling only the upper portion of the B-pillars (see picture above), which carry most of the roof-crush load, with foam resulted in a substantial 14% strength improvement.[1]
- While improving strength, foam treatments can also help reduce vehicle weight. One case study demonstrated that applying foam to the front rail under floor, B pillar to rocker and B pillar to roof reduced weight by 16.2 kg compared to sheet metal [35.71 lbs.].[3]
- Another simulation demonstrated that plastic foam has the potential to save space for additional energy absorbing structures such as head impact safety components. A section of B-pillar 20mm narrower than an unfilled section resulted in nearly the same strength as the unfilled pillar—the foam filling helped reduce the section sizes in the B-pillars without appreciable loss of strength or increase in mass, creating extra space.[1]

Foam injected into the pillar assumes its shape.

Bending test on a steel tube filled with 6 pcf density of polyurethane foam. These indentations are caused by energy absorbing foam compression locally, NOT section collapse.



Bending test: End of hollow steel tube deformation vs. end of foam-filled tube.

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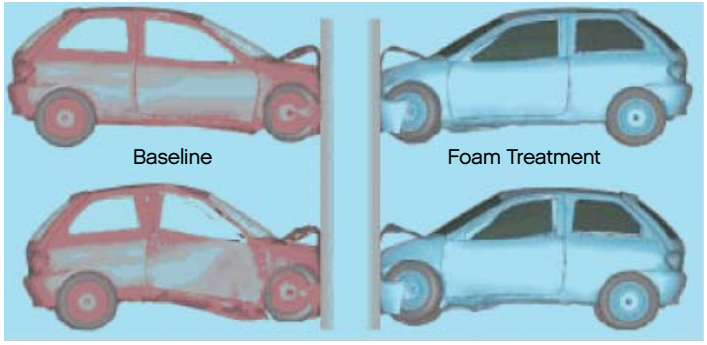
Additional Information

- Current applications for structural plastic foam include body-side joints, sills, pillars, underbody cross-car structure, frame rails/longitudinal structure, door panels, engine cradles, lateral rails, and hydroformed reinforcements.[3]
- According to an auto authority, with an expertise in crashworthiness, "When an accident occurs involving roof structures with a filled inner space, the outcome has been shown to be safer due to a lesser amount of roof crush. Pillars filled with high-density foam can reduce the severity of a roof crush significantly, saving lives and reducing serious injuries."[4]
- The density of the foam material is a critical parameter for strength applications, as higher density implies higher strength. Because higher density foam has greater mass, however, a density range is usually selected that provides strength without substantial weight gain.[1]
- Injecting foam into hollow steel structures—the "foam-in-place process"—has been in production since 1982 and over 2 million North American cars and trucks per year use low-density and high-density foam for various purposes.[1]
- In a study that was featured in the Journal of Materials Engineering and Performance, no corrosive effects or foam degradation were evident in either durability testing or production vehicles.[1]



Lightweight foam applied to the front rail, front rail under floor, and roof rail can also help absorb energy in front end crashes, which can help protect the passengers inside.

Works Cited

1 Lilley, K. and A. Mani. "Roof-Crush Strength Improvement Using Rigid Polyurethane Foam." Journal of Materials Engineering and Performance 7, no. 4 (August 1998): 511-514.

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3 Dow Automotive. BETAFOAM Structural Foams. (Auburn Hills, MI: The Dow Chemical Company, 2006), a brochure, available at http://www.dow.com/PublishedLiterature/dh_0550/09002f13805508e3.pdf?filepath=automotive/pdfs/noreg/299-50613.pdf&fromPage=GetDoc (accessed May 4, 2006).

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Pictures

Plastic Foam Pillar Inset: Courtesy of Dow Automotive

Plastic Foam 1, 2, 3: Lilley, K. and A. Mani. "Roof-Crush Strength Improvement Using Rigid Polyurethane Foam." Journal of Materials Engineering and Performance 7, no. 4 (August 1998): 511-514.

Plastic Foam Crash Test: Courtesy of Dow Automotive

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