"Do Tougher Standards Lead to Better Helmets?"

by

S.R. Sarrailhe

Discussion By

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The Sarrailhe paper poses in its title an interesting question. It does not however, provide a definitive answer. Certainly if "tougher" means more stringent or demanding, then this could hardly be argued as not being better. If, however, as the author implies, tougher means stronger (i.e., "... the liner may be too hard ..."), then this may not always be in the best interest of the helmet wearer. It is Sarrailhe's opinion that contemporary standards do in fact produce helmets that are too strong.

The author cites, in support of this conclusion, the work of Hurt in which it was observed that in the cases where liner crush was measured, permanent deformation was less than 5 mm in 95% of the cases and it was never more than 11 mm. These observations may not be a true reflection of the amount of crush than that the helmet liner may have undergone during impact.

In controlled impact tests of expanded polystyrene bead foam, typical of that used in motorcycle helmet applications, this author has found that permanent set or visible crush may not correlate well to the maximum crush.

The photographs of Figure 1 are selected frames from high-speed motion pictures showing symetric biaxial impact loading of such a material. The rebounded height of the sample shown in Figure 1(c) is not very different from the initial uncrushed height. The absolute extent of crushing shown in Figure 1(b) is, however, far greater than would be suggested from a visual examination of the sample after the event.

Sarrailhe's criticism stems from the use of a rigid headform; long an issue of concern. There is, of course, little argument that a cast magnesium headform is stiffer than that of the human head. However, this has always been considered by this author to be an error on the conservative side. It should be noted that Hurt did find that contemporary helmets (presumably tested and certified on a rigid metal headform) provided a "spectacular" level of head impact protection.

The critical situation in helmet design is that of a "bottoming out" of the liner (the situation shown in Figure 1(b). Since a rigid headform absorbs no energy, it is more responsive to the onset of this critical condition than would a headform that yields or deforms. It thus does force manufacturers to build in a safety margin since they cannot rely on any energy absorbing mechanism other than the helmet itself.

If helmet liners are too hard, and field evidence is inconclusive in this regard, it is more likely to be associated with the improper shape of the current magnesium headform, not its stiffness. The shape of the current DoT/Z90 headform is such that it is not well distributed within the interior of most helmets. The human head is much more so. Relatively localized loading by a metal headform does produce substantial crushing at typical standard impact levels. Due however to the more distributed loading by the human head, the material may be effectively stronger and thus less crushable.

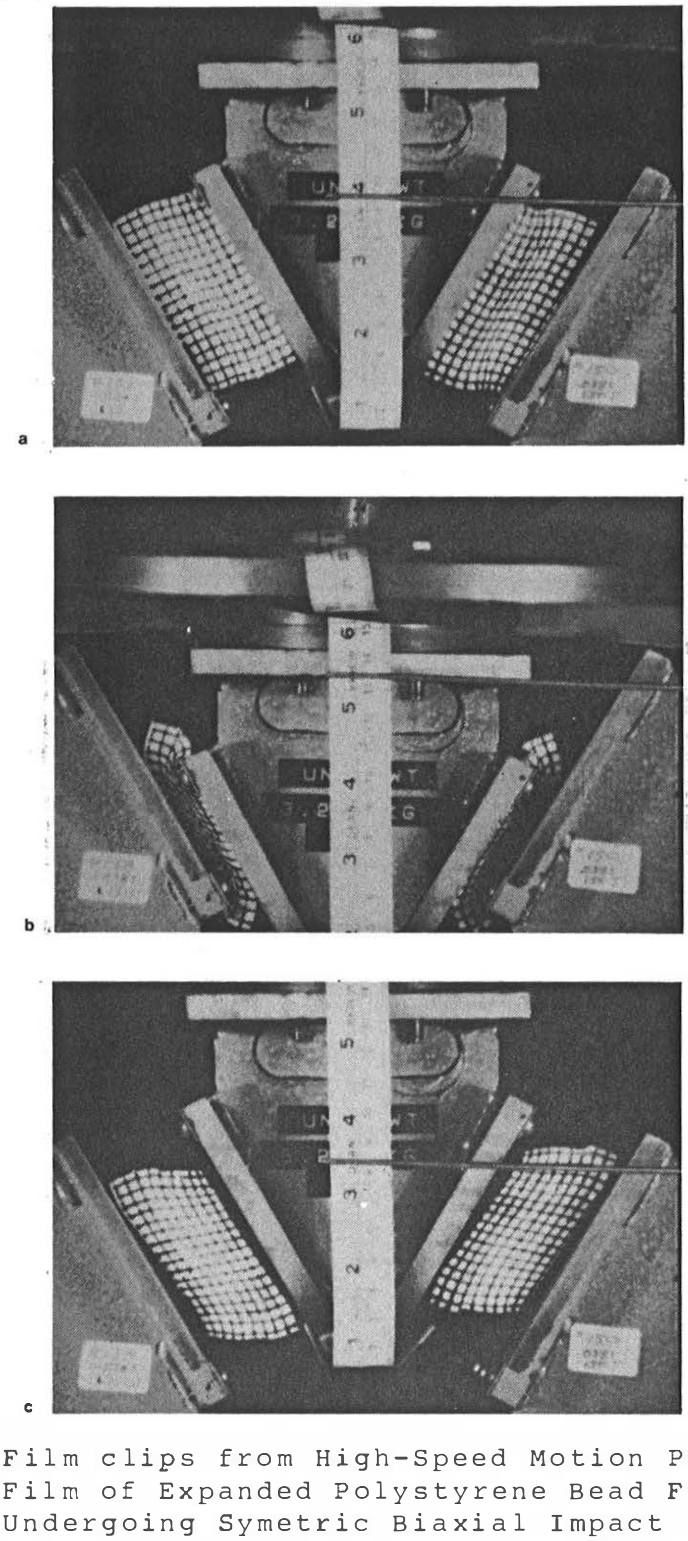

Figure 1: Film clips from High-Speed Motion Picture Film of Expanded Polystyrene Bead Foam Undergoing Symetric Biaxial Impact Loading.
Figure 1(a) shortly after initial contact.
Figure 1(b) Maximum Compression.
Figure 1(c) End of Impact Event.