Impact Resistant Support Columns

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Introduction

Issues related to increasing the safety of mankind has been an ever increasing concern. When looking back on the past, the creation of the bullet proof vest, the first airbag in an automobile, steel toed shoes, storm shutters and shatter proof glass have all been considered great milestones to safety improvement. These examples are all similar in that they all aid to reducing the effects of impact.

There are many different devises that are designed to reduce or eliminate the damage from a projectile by absorbing the energy of the impact. A majority of these are simple aspects that can handle repeated impacts without failure, but there are also designs of impact barriers that are intended to only receive one significant collision with non-recoverable deformation. These single use barriers utilize different strategies to withstanding an impact, but a common strategy is to maximize the moment of inertia of closely spaced features in the direction of impact. The “honeycomb method” can be seen as an example of this which has been used for years by Reebok in many of the shoes they produce.

Thin rectangular features that are aligned parallel to one another are likely to achieve the same effect as the honeycomb. If these planes were securely spaced, it is assumed that the feature could handle large amount of directional pressure or impact. It is realized that the dimensions of this concept are highly variable to compensate for the specific application that is desired.

This concept can be applicable to a variety of applications such as highway barriers, guide rails or in the front and rear bumpers of automobiles. Sections of the impact columns could be stacked and layered to form a specific geometry for the desired use. As the column is exposed to an impact, the rectangular planes will begin to deflect and expand to the free space between the rectangular features. This deflection would drastically aid to supporting the impact load and demonstrates the purpose of this concept.

Application of Blow Molding

Extrusion blow molding is definitely the most appropriate production process to achieve such a product. The main concept of having parallel planes that are supported by a center column can easily be created from blowing a parison to a mold cavity with such geometry. The hollow part created from blow molding will be lightweight and the plastic material used in the process will naturally have impact resistant qualities.

Design Details

The main idea behind this concept is to maximize the moment of inertia in the direction of anticipated impact while minimizing material usage. The rectangular feature’s geometry, spacing of the rectangular features, material and additives to the material would all directly
affect the impact properties. The ratio of length to width of the rectangular feature will be the primary modification made to the geometry to optimize for the intended application. Ideally the length of the rectangular feature should be maximized with respect to width to generate the largest moment of inertia, but the influence of parison thinning will limit the ratio of length to width to approximately 2:1.

The thickness of the rectangular planes should be great enough to allow for adequate parison stretching to extend to the end of the cavity. It is realized that the wall thickness will decrease as the parison stretches to the end of the cavity. Too small of a thickness will result in a very thin wall thickness at the end of the rectangular feature.

The material selection for this application would most likely be a polyolefin because of their relatively low elastic modulus which will allow for deflection during impact. Plasticizers could be used to decrease the elastic modulus and the reflected deflection load seen during impact.

**Mold and Tooling Details**

The mold used to produce this concept would be symmetric and relatively easy to machine since the geometry is basic. The tolerance to mold machining would be large because the part does not contain any critical dimensions. The surface finish of the part is also not critical and polishing would not be necessary. Taking into account of the large tolerances and insignificant surface finish on the easily machinable design, the cost of producing a mold will be very affordable. The mold could be machined out of aluminum which would provide benefits of easy machining and high thermal conductivity.

**Manufacturing Details**

If a circular parison is utilized to form the part, the wall thickness will be thin along the outer corners of the rectangular feature as well as the face of the shorter side. An ovalized parison could be designed to allow for a more evenly distributed wall thickness to provide more material to be stretched in the length direction of the rectangular feature. The geometry of the die and mandrel could be altered to optimize the wall thickness variation.

The blow molding production process would allow for the support columns to be produced with a short cycle time and in large quantities. The cycle time of the process will likely be determined by the cooling time of the part. Cooling time will vary with the specific design of the support column and the associated wall thickness.
Design Drawings

Figure 1. Two mold halves illustrating the pinch off and flash pockets

Figure 2. Stacked Support Columns

Figure 3. Ideal ovalized parison
Figure 4. Drawing of an impact column

Figure 4. ANSYS simulation of directional deformation before and after loading