

# TOP FIVE QUESTIONS ASKED ABOUT COMPRESSION MOLDING

DeWayne Howell, Senior Application Engineer & Project Manager, Expert Services at Toray

Besides “How much will a compression molded part cost?”, we explore five of the most asked compression molding questions:

**Q1** How much thicker does a compression molded composite part have to be versus a metal part to achieve the same stiffness?

**A1** The answer depends upon how the metal part is loaded. Is the part subjected to bending, tension, or compression loads? In general, if the part is tension or compression loaded, then a simple ratio of metal part thickness to its extensional modulus, multiplied by the Bulk Molding Compound (BMC) material modulus (tension, compression, or flexural), will be the answer. If the part is loaded in bending, then making the part thicker would work, but that is not necessary. Ribs are easily added to a compression molded part.



Ribs add additional stiffness with negligible material weight increase. The Toray Compression Molding Design Guide offers answers to these questions for a variety of metals compared to BMC, using easy to navigate graphs.

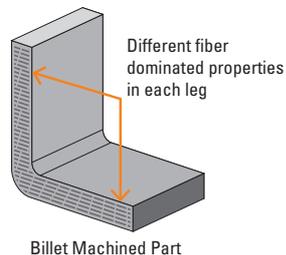
**Q2** How much does tooling cost?

**A2** Since compression molding long-fiber BMC with high-fiber content requires very high pressures up to 138 bar (2000 psi) to fill complex features, matched-metal tooling is required. Also, tolerances on the core and cavity halves of the tool need to be very tightly controlled so that entrapped air can escape while fiber and resin cannot. This combination of requirements can drive the cost of tooling upward beyond the basic cost of lamination tooling made from composite materials. However, this cost will be lower than an injection molding tool. A rule-of-thumb for sufficient tooling return on investment is that the tool's cost will be covered with 1000 production units. Of course, this can be higher if the part is highly complex and lower if it is not. Aluminum molds are lower priced than steel, but they are less suitable for higher volume production runs. Multiple cavity tools can also help to

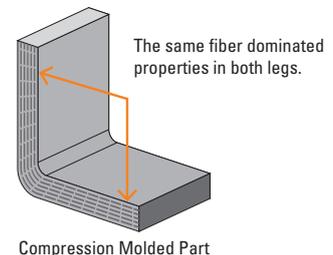
reduce the mold costs as more parts are produced per mold cycle.

**Q3** Why does billet stock not truly replicate the 3D behavior of a compression molded part?

**A3** Billet stock compression molded blocks are an excellent alternative to procuring a costly part-specific mold. Billet can be a key time and cost saver when several geometry iterations on a part are anticipated in the prototype phase. It can also save the cost of molds altogether if only a few parts are needed. Simply machine the part from a billet; think custom hog-out of a metal block to produce a part. However, there is one fundamental limitation to machining from billet stock. The billet block or plate is compression molded with BMC chips. These chips will layer into the compression molding tool with a near quasi-isotropic fiber dominated lay-up in the plane of the plate, but will be resin dominated through the thickness. Therefore, if the machined part has a feature that needs strength in the direction out of plane, this cannot be attained.



Billet Machined Part



Compression Molded Part

Pictured above is an L-shaped part. One leg of the “L” will have strong and stiff fiber properties and the other perpendicular leg will be weak, as it is resin dominated in the direction along the leg. To the contrary, a molded part would have the same fiber-dominated properties in both legs.

**Q4** How does one learn if compression molded parts are viable?

**A4** The best place to start is to request a copy of the Toray Compression Molding Design Guide, *Design Guidance for Long Chopper Fiber Compression Molding* from our online resource center at [www.toraytac.com/processing-guides](http://www.toraytac.com/processing-guides). The guide describes the process, lists material properties, gives recommendations on structurally designing a part, shows the resulting tolerances, describes part features that are difficult to mold and those that are straightforward, and

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details many of the little nuances to designing a part for compression molding. The next step is to talk to a member of Toray Advanced Composites Expert Services team about the part and the requirements. We'll ask for a 3D model of the current part. We'll review the model and provide a list of recommended changes to the part to make it more compression mold friendly.

**Q5** How do I structurally analyze a discontinuous fiber compression molded part?

**A5** This question stems from the fact that BMC parts made from discontinuous fibers can take on fiber alignments other than quasi-isotropic, and are geometry dependent. As fiber is placed into the mold cavity, it tends to layer like a continuous fiber composite lay-up. Fibers away from the sides of the mold will generally take on an in-plane quasi-isotropic lay-up orientation. At the edges of the mold, fibers tend to orient themselves parallel to the edge, making the properties around the edge of the part more orthotropic. The exact orientations are difficult to ascertain, thus making analysis difficult to do. But, fiber orientation assumptions, based upon the above, can be made and an orthotropic FEA model can be created. Beyond this, it is possible to better approximate orientations using X-rays and destructive methods on prototype parts. All the above applies to thermoset BMC that is placed directly into mold features and does not move much in the tool during molding. For thermoplastics that are placed into the tool as a charge, there are flow models that can predict fiber angles as the BMC is pushed into different regions of the tool during molding. These flow models can be interfaced with FEA models that read the fiber directions and predict resulting part performance.

For more product information such as product data sheets, case studies, or technical papers, please use the following resources:



Search for the **Toray TAC Product Selector**



[www.toraytac.com/compressionmoldedparts](http://www.toraytac.com/compressionmoldedparts)

Go to our online resource center for product data sheets and technical resources.



## Toray Compression Molding Design Guide

To request a printed copy of this design guide, go to [www.toraytac.com/processing-guides](http://www.toraytac.com/processing-guides)

## MOLDED PART OBJECTIVES



Lightweight complex parts



High-strength structure



Rapid part forming

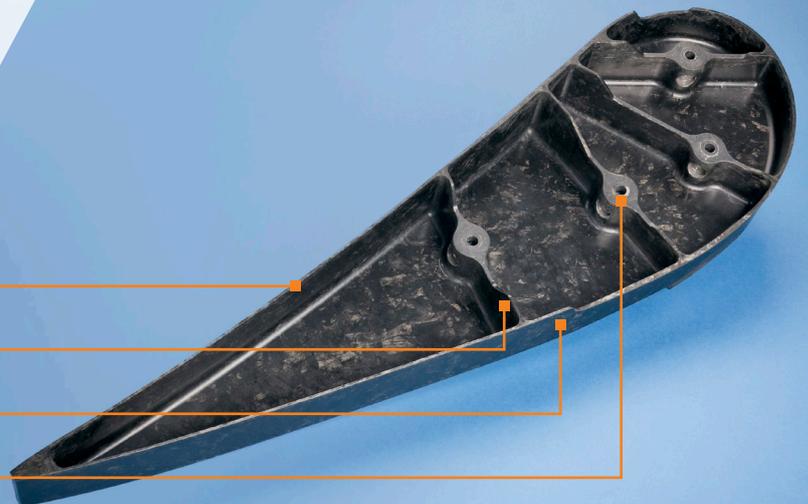
LIGHTWEIGHT

COMPLEX PART FABRICATION

OPTIMIZED LOAD PATHS

LIGHTNING PROTECTION

INTEGRATED FASTENERS



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