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# Additive manufacturing Gyroid structures used as crash energy management

A.A. Garcia Granada; F.J. López Valdés; G. Reyes Pozo; H. Rostro González; J.M. Puigoriol Forcada; s.s. Sundarram

**Abstract-**

**Gyroid-like structures are promising in terms of energy absorption levels. Due to additive manufacturing, they can now be manufactured and verified for different functions. In this article, it has been proven that a Gyroid manufactured by FDM using PLA with 0.2 relative density must be oriented so that compression takes place along the build direction to obtain higher levels of force and energy. The Gyroid can be scaled, allowing the use of a single compression curve with almost constant forces up to 50% compression. The model to predict properties as a function of relative density fits well with a power-law for n = 2.2. The ability of the Gyroid to absorb energy per kilogram is about seven times lower than that of a solid PLA cube, but it can be used to obtain desired levels of deceleration. It is possible to use a simple constant deceleration model to define the Gyroid size, mass, and velocity of the object to be impacted. The use of this approach allows the tailored combination of Gyroid sizes to meet multi-objective impact targets. The simulation of impacts with a finite element model of only 125 solid elements is possible with errors below 10%. By combining different Gyroid sizes, two different safety regulations can be met. Modeling the Gyroid by meshing the real geometry allows for the local maximum force magnified at high strain rates, but it is not able to correctly predict densification.**

**Index Terms- crash; Gyroid; explicit; plasticity; FDM; PLA**



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