

Schwarzite Metamaterial For Damping Enhancement And Vibration Isolation

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Schwarzites are 3-Dimensional solids with a negative Gaussian curvature at every point. These structures are hypothesized to have a very stable geometry. Consequently, macro-scale Schwarzites have been manufactured by additive manufacturing and they have been found to have interesting mechanical properties, including high ductility and strength, which results in high energy dissipation. Energy dissipation is particularly important in controlling the vibrations in dynamic systems. Therefore, in this study, hysteretic energy dissipation of Schwarzites is characterized and the possibility of channelling the hysteretic energy dissipation for controlling structural vibrations has been investigated and is compared to that of a solid geometry. For this, experiments were conducted to get the response of Schwarzites and solid specimens under cyclic loading and the Bouc-wen model was used to capture the response of the two geometries. Further, dynamic simulations were performed to characterize the damping offered by the two geometries. It is found that owing to its more efficient energy dissipation, Schwarzite geometry increases the damping ratio by 80% compared to solid geometry using the same amount of material. It has also been found that Schwarzite geometry balances the capacity and demand in both tension and compression in a more efficient manner than its solid counterpart, thus resulting in more efficient use of material. The broader impact of this study is to highlight that the architected material - with more efficient use of the same amount of material - can offer vibration isolation and enhanced damping properties, which can be harnessed for vibration reduction applications.