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INFILL ANALYSIS AND OPTIMIZATION IN ADDITIVE MANUFACTURING APPLICATIONS

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Abstract: Recent advances in additive manufacturing make possible the manufacture of mechanical components that achieve enhanced performance by means of complex lattice microstructures. In addition to weight reduction and increased stiffness, the lattice can be tailored to satisfy multiple performance specifications, including some that demand multiphysics and multiscale analyses. Spatial variations are no longer limited to simple periodic tilings of a single characteristic cell. Instead, the spatial variation of the lattice, and even its topology, can be controlled to achieve enhanced performance while remaining manufacturable through advanced additive manufacturing technologies. One application of these complex lattice patterns is as "infill" in 3D printed parts. Optionally, the part may have a solid outside shell and solid internal walls, but internal cavities are occupied by a carefully designed lattice infill. The scale of the lattice may be small when compared to the scale of the part itself, even approaching scales that are more typical of a porous material. With recent advances in additive manufacturing, it is possible to design the infill in detail and optimize its (geometric) properties, even at small scales. In this work we investigate the effect of using different micro geometries in (3D) mechanical parts constructed by additive manufacturing. We allow spatial variations of parametric properties, lattice positioning and scaling, and lattice topology. The work includes an investigation of the effective mechanical properties of different lattice micro geometries. We use as our principal examples weight constrained problems involving stiffness maximization, although the methodology can be adapted to other performance criteria.