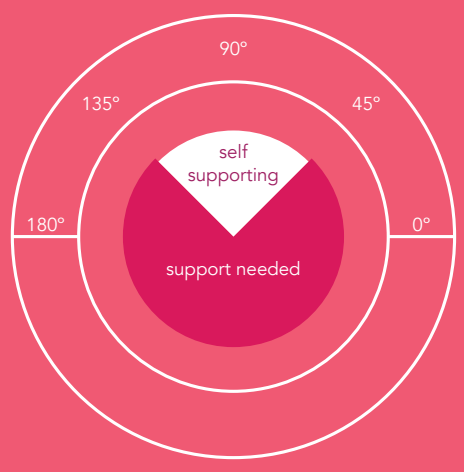
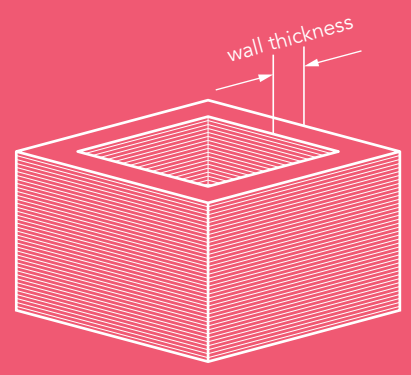
3D Printing design guidelines

Geometrically complex parts can be made with relative ease using 3D printing compared to traditional subtractive manufacturing methods. However, the technique is not suitable for all parts and failure to account for its limitations during the design and print of a part can significantly impact part quality and performance.



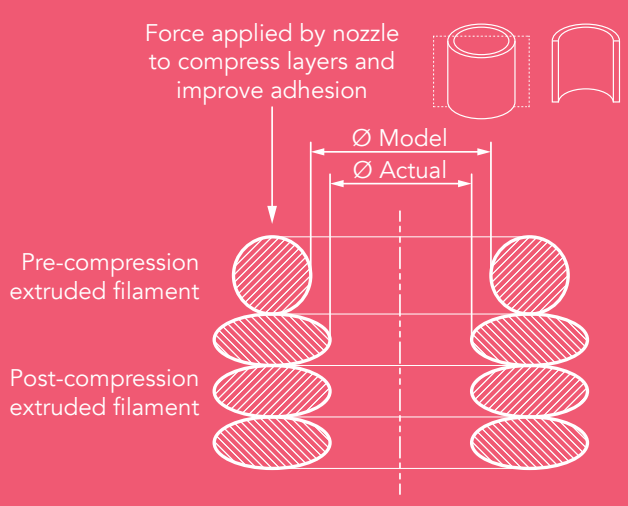
Overhangs

*Part surfaces at **45° or greater** to the build plate are generally self-supporting i.e. require no support material. This improves the printed part performance and overall quality.*



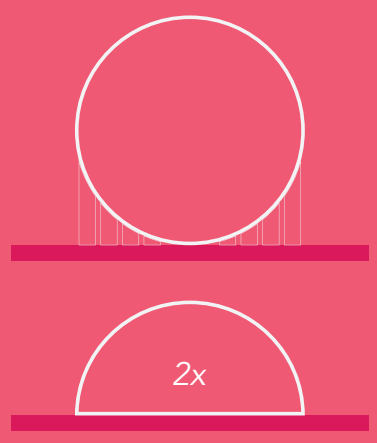
Wall thickness

*The minimum wall thickness of any feature in a part should be no less than **four times the print layer height**. Thinner wall sections are unlikely to print correctly, impacting part quality.*



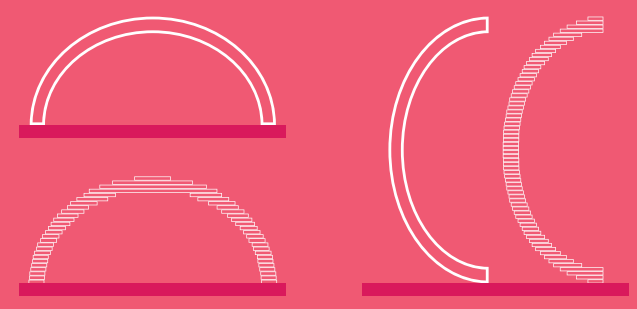
Printing tolerances

*3D printer tool-paths do not always account for filament spread which results in dimensional inaccuracy. Small holes should therefore be **oversized** by around 0.5mm.*



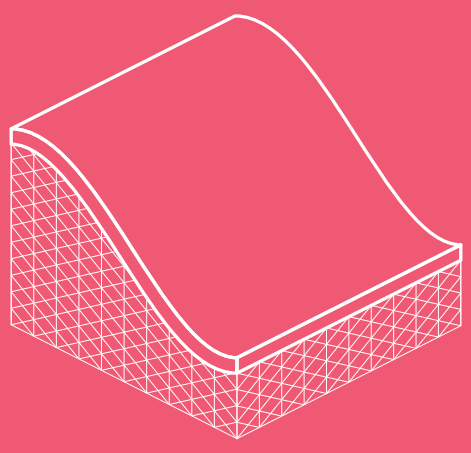
Printing large objects

*Large parts can be split to reduce the need for support material and improve anchorage to the build plate. **Parts should be split dependent on their final use** i.e. to maximise stiffness.*



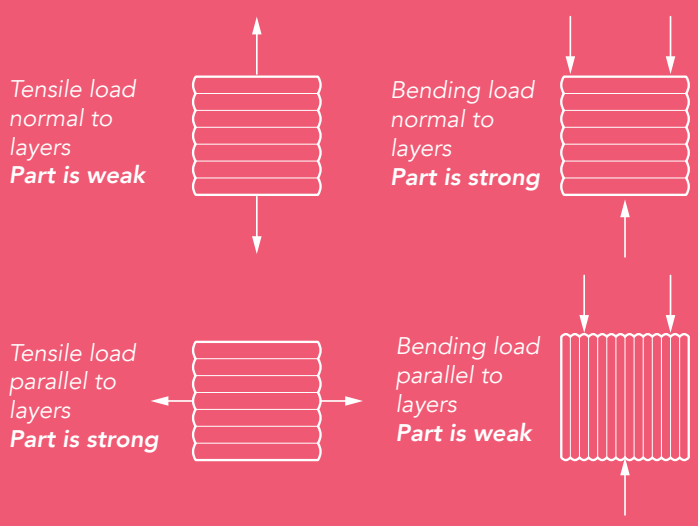
Print orientation

*Part orientation on the print bed affects cylindricity and curvature quality, as well as bed adhesion and support material requirements. **Print orientation should be considered during part design.***



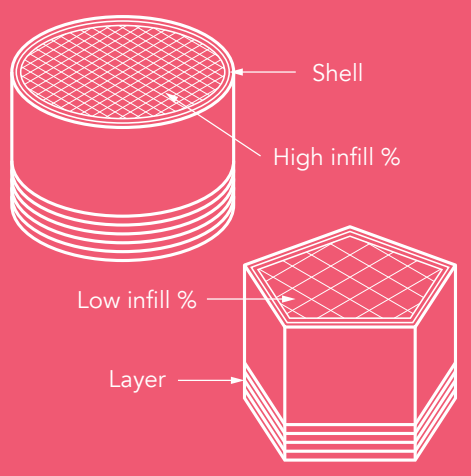
Support material

Support and print material on single extruder 3D printers is the same making them difficult to separate. Some slicing software can minimise support material using "trees structures" and other options e.g. Meshmixer, Cura, Slic3r.



Anisotropy

Printed parts are anisotropic and are susceptible to delamination. Parts are strongest when tensile loads are parallel to layer orientation or bending loads are normal to layers.



Layer height, infill and shell count

*Layer height is the step in z-axis between slices. **Smaller layer heights increase print time without necessarily improving part performance or quality.** Shells are the number of perimeters of a layer. Higher shell counts can increase surface quality. Infill % impacts part strength and stiffness. Alternative manufacturing methods should be considered for functional parts requiring infill higher than 40%.*

By Duncan Boa & David Mathias