How many walls make a 3D print watertight?

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Abstract. Four perimeters held water in PLA and PETG in Prusa's tests, two in ABS and PP, and one vase-mode wall in every material. Flow and layer height matter too.

Keywords: watertight, waterproofing, slicer-settings

1 How many perimeters make a print watertight?

In Prusa Research's leak tests, four perimeters was the minimum that held water in PLA, PETG and nylon; two was enough in ABS, ASA, PC and PP. Raising the extrusion multiplier to 105 to 110 percent and printing 0.15 mm layers improves the odds. A single vase mode (spiralize outer contour) wall was watertight in every material they tried.

1.1 Minimum perimeters by material

Table 1. Minimum perimeters by material

Material	Minimum perimeters that held water
PP, CPE, PC, ASA, ABS	2
TPEE	3
PLA, PETG, nylon	4
HIPS, PVB	5
Any tested material, printed in vase mode	1

In full: PP is polypropylene, CPE a co-polyester, PC polycarbonate, ASA acrylonitrile styrene acrylate, ABS acrylonitrile butadiene styrene, TPEE a thermoplastic polyester elastomer, PLA polylactic acid, PETG glycol-modified PET, HIPS high-impact polystyrene and PVB polyvinyl butyral.

The figures come from Prusa Research's Watertight 3D printing part 1 post, which found most parts fine at 4 to 6 perimeters, about 2 to 3 mm of wall. The post does not state the line width behind the counts, so treat them as a floor. Prusa's Knowledge Base says start at 3 to 4 and go to 5 to 6 if the geometry allows.

1.2 Why wall count matters

Leaks rarely come through the layers. Prusa traced most of them to the seam where each layer starts and ends, and to the transitions between solid infill and perimeters. Thick walls with sparse infill inside can also leak into the voids between infill lines. Each extra perimeter is one more overlapped line that has to fail in the same spot.

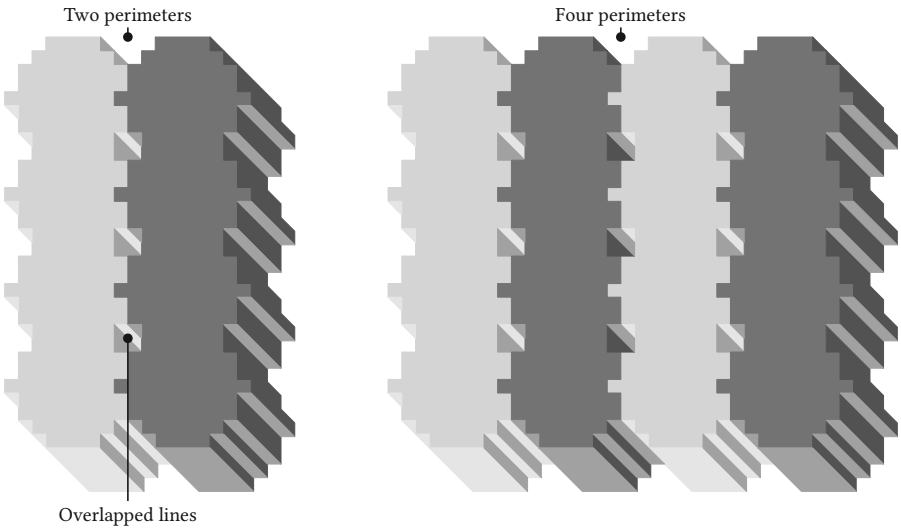


Figure 1. Each perimeter is one more overlapped line that a leak has to get past, so the wall with more of them gives water a longer path.

Wall count is a proxy for thickness. PrusaSlicer overlaps neighboring perimeters so they bond, which is why two 0.45 mm perimeters give a 0.86 mm wall, not 0.90 mm. A wider line makes a thicker wall at the same count. Prusa suggests widening the external perimeter from 0.45 to 0.6 mm for a watertight vase.

Flow matters as much as count. Under-extrusion leaves channels between lines. Prusa recommends an extrusion multiplier of 105 to 110 percent, or a line 5 to 10 percent wider, plus a nozzle 5 to 10 °C hotter. Raising PrusaSlicer's infill and perimeter overlap from its 10 percent default to 25 to 35 percent closes the gap at the wall.

Thinner layers help. In the same tests, 0.05 mm layers leaked least and 0.3 mm layers leaked most.

Get it wrong and the failure is slow: the print weeps at the seam or sweats through the wall, so a quick pour can pass a part that fails in use.

1.3 How to check it on your own print

1. Print the part with the settings you intend to use and let it cool.
2. Stand it on a dry paper towel and fill it to the brim with water.
3. Check the towel and the wall after a few minutes. Look hardest at the seam.
4. If dry, leave it filled for several hours and check again.
5. Read the result: a wet seam points at flow or temperature, damp patches across the wall at too few perimeters.

The timed version, with pass criteria after one night and after 48 hours, is on how to test a print for leaks.

References

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